

# Field Study Results: Mars Generation One

## Introduction

This report presents findings from a field study of Mars Generation One: Argubot Academy, an argumentation game developed by GlassLab Games in collaboration with Educational Testing Service (ETS) and Pearson, with support from the National Writing Project and NASA. Mars Generation One (MGO)[1] teaches and assesses students' argumentation skills through an adventure-based educational game for the iPad.

## About MGO

In MGO, the year is 2054. The setting is the first human settlement on Mars. Citizens resolve their differences and make important policy decisions by sending robot assistants—called “argubots”—into debates reminiscent of the assemblies in ancient Greece. Aligned to Common Core ELA standards for the middle school grades, the game introduces and develops players' core argumentation skills. These include identifying evidence in text, organizing evidence to support claims, and evaluating and critiquing arguments through use of critical questions.

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## Key Findings

- **Learning Impact:** Students who play Mars Generation One for three hours with two hours of instruction can make as much as one year of learning gains.
- **Valid Assessment:** Mars Generation One provides valid assessment information about students' argumentation ability.
- **Effective Motivation:** Mars Generation One motivates students to learn challenging argumentation skills.



## Research Questions

1. Do students make significant learning gains in argumentation ability after taking part in the MGO game and curriculum?
2. Are MGO in-game outcomes valid assessments of students' argumentation ability?
3. Does MGO motivate students to learn argumentation?

## The MGO Field Study

To answer these research questions, we recruited twelve middle school teachers from across the country to implement the Mars Generation One game and curriculum in their classrooms in the Fall of 2014. Over 500 (n=589) students in grades 5-8 took part and represented a range of socioeconomic backgrounds. Before starting the MGO experience, all students completed a short pre-test to assess their argumentation skills. This test, as well as the post-test that students completed following the MGO experience, was created by ETS to evaluate the key aspects of argumentation targeted in MGO. In addition to the pre-post test, following the MGO experience students also completed a brief motivation survey, as well as one of the ETS CBAL™ [2] argumentation assessments.

The MGO experience itself combines game play with whole-class and small-group activities. The MGO instructional supports provide teachers with lesson plans and materials for classroom activities, which prepare students for a productive gameplay experience, as well as reinforce key concepts through debriefing activities. The MGO experience is designed to span as few as five periods and as many as 15 periods of classroom implementation. Teachers in the field study implemented the condensed, 5-day MGO experience that combines two lesson plans with five game-play sessions. Figure 1 shows the typical implementation timeline for the field study.

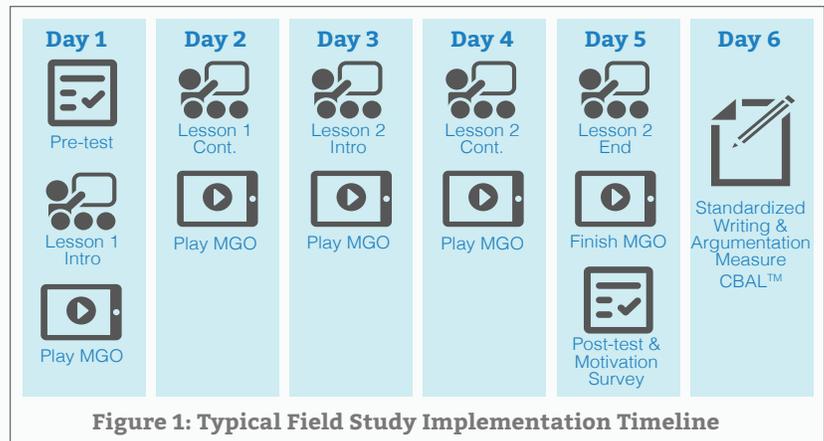
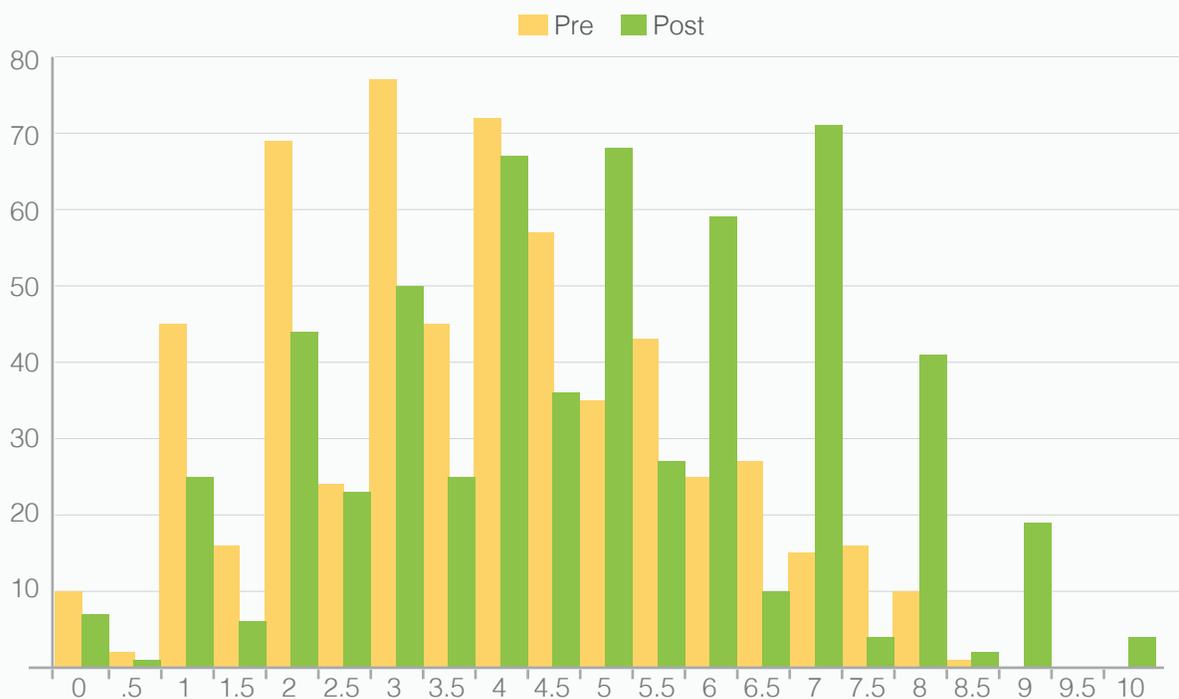


Figure 1: Typical Field Study Implementation Timeline

## Results

### Research Question 1: Learning Gains.

To determine whether students in the field study made significant learning gains in their argumentation ability, ETS researchers compared their pre-test scores to their post-test scores. As shown in Figure 2, results indicated a statistically significant improvement from pre-test to post-test ( $t(588)=10.702, p<.001$ ). Students' average score increased from 40% on the pre-test to 49% on the post-test. Figure 2 shows the distribution of the pre-test and post-test scores, and evidences the positive trend. Moreover, the majority (65%) of students improved from pre-test to post-test, suggesting that MGO is effective across a broad range of students.



**Figure 2: Distribution of Students' Pre-Test and Post-Test Scores**

Importantly, there was a statistically significant correlation between students' post-test scores and their CBAL scores, both of which were obtained following students' exposure to the MGO game and curriculum. The relation between the two measures was used to calculate a best estimate of students' CBAL score prior to their exposure to the MGO experience. From there, ETS researchers could generate a quantitative estimate of students' progress on the CBAL trajectory. The CBAL argumentation trajectory describes a path from elementary school through college, with five steps along the way. Along the 5-point CBAL scoring scale, students are expected to achieve a score of "2" by the end of elementary school, a "3" by the end of middle school, and a "5" by the end of college. Based on the projected scores, students increased by approximately a half point (0.47) along this scale from when they started to when they completed the MGO game and curriculum. Since CBAL expects students to spend three years of middle school to move forward one point from a "2" to a "3", these results can be interpreted to suggest that students can make as much as a year or more of learning gains by engaging for five hours in the MGO game and curriculum experience.

Generally, it was found that kids who play the game can increase their competency significantly in identifying argument components, organizing arguments, and evaluating the arguments of others. For students just beginning argumentation in middle school, the game can help them move from skills such as identifying a reason or piece of evidence that supports a specific claim towards being able to identify and generate multiple reasons in an argument. For students with a higher level of competency in argumentation the game can help move them from skills such as identifying and organizing multiple pieces of evidence that support a claim towards being able to evaluate others' more complex arguments and rebut others' critiques of their own arguments.

### Research Question 2: Assessment Validity.

As students play MGO, data from their gameplay is used to assess their competency in key aspects of argumentation. GlassLab's application of evidence-centered design to create MGO made it possible to draw claims about students' argumentation ability. We carefully constructed game experiences to align closely to key aspects of argumentation, including identifying evidence, constructing arguments, and evaluating and critiquing the arguments of others. To calculate each student's argumentation ability, researchers at ETS first examined the game-based data



points to confirm their statistically significant correlations to the CBAL assessment. They then assembled these data points into a form of assessment model known as Bayes' Nets, which are probabilistic in nature and relate multiple sources of data to make predictions about a level of proficiency (e.g., foundational, proficient). Increasingly, this approach has been used for successful assessment in learning games [3,4]. For MGO, key game-based data used in the assessment model include the fusion of strong evidence and claims, identifying illogical arguments through critique of opponents, and using critical questions as an argumentation strategy (e.g., to weaken opponents' assertions during an argubot battle).

To confirm that the final game-based assessment models provide valid insights into students' argumentation ability, each student's game outcome was correlated to their score on the externally developed and validated CBAL assessment. Results found statistically significant correlations between the two assessments. This revealed that generally, students' game-based argumentation level is in accord with their scores on the CBAL task, a second measure of argumentation. In other words, students' performance on MGO can be interpreted as providing valid information about their argumentation ability—not just their ability to play the game. In-game success appears to be a valid indicator of argumentation ability.

### Research Question 3: Motivation.

The third research question asked whether MGO successfully motivated students. Students responded to questions on an external measure created by ETS to measure aspects of motivation. Results indicate that in addition to being a valid instrument for learning and assessment, MGO effectively motivated students. Over 80% of students reported persisting through hard parts of the game, and 72% of students reported that the game taught them “a lot” about good argumentation. Students' responses to the engagement survey were analyzed to discern whether they were engaged during gameplay, and tested whether student scores on the two engagement sub-scales, effort and importance, were higher than previously published scale midpoint responses [2]. Results confirmed strong engagement of students during MGO gameplay, and one-sample t-tests comparing average scores on both sub-scales to the scale midpoints showed that scores on both sub-scales significantly exceeded moderate levels of effort and importance (Effort:  $t(434)=21.089, p<.001$ ; Importance:  $t(434)=11.432, p<.001$ ).

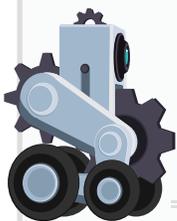
## Conclusion

Mars Generation One: Argubot Academy represents a holistic effort to integrate the power of engaging gameplay, challenging argumentation skills, and insightful formative assessment into one learning vehicle. This study has shown that MGO's complex design effort is yielding promising results and that careful, principled design is critical to enabling valid claims about learning.

Overall, results show that students who play MGO for five hours can make as much as one year of learning gains in key aspects of argumentation. This reflects the effectiveness of core gameplay actions in teaching argumentation, and also validates the game-based real-time assessments that produce an argumentation skill level for each player. These in-game measures of learning are validated by an external measure of argumentation (from CBAL™), a robust computer-based exam created by the Educational Testing Service. The results support the efficacy of MGO as an engaging, effective educational experience, and a formative assessment engine that provides deep insight into real-time student learning.

### References

1. <https://www.glasslabgames.org/games/AA-1>
2. More information about the ETS CBAL™ initiative and argumentation assessment are available at <http://elalp.cbalwiki.ets.org> and [http://www.ets.org/Media/Research/pdf/RD\\_Connections\\_22.pdf](http://www.ets.org/Media/Research/pdf/RD_Connections_22.pdf)
3. Shute, V. J. (2011). Stealth assessment in computer-based games to support learning. *Computer Games and Instruction*, 55 (2), 503–524.
4. Mislevy, R.J., Corrigan, S., Oranje, A., Dicerbo, K., John, M., Bauer, M.I., Hoffman, E., von Davier, A.A., Hao, J. (2014). Psychometric considerations in game-based assessment. Redwood City, CA: GlassLab.



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#### Partners



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