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Associations Between Student Use of Beast Academy Online and Performance on End-of-Year Math Assessments

Prepared for
Art of Problem Solving

THE UNIVERSITY OF UTAH
UTAH EDUCATION POLICY CENTER

Bridging Research, Policy, and Practice

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1 | Executive Summary

This report presents findings from an independent evaluation of **Beast Academy Online**, a digital mathematics learning platform for elementary students, conducted by the Utah Education Policy Center (UEPC) in partnership with Art of Problem Solving. The study focused on 12 elementary schools in Davis School District during the 2024–2025 academic year and aimed to understand how student engagement with the platform relates to mathematics achievement, particularly for high-ability learners.

Key Findings

- **Usage Patterns:** Student engagement with Beast Academy Online was generally consistent throughout the school year, with expected declines during holiday periods. The median monthly usage was modest (approximately 29 minutes), but the vast majority of students who spent time on the platform made clear progress.
- **Academic Outcomes:** Greater usage was positively associated with higher end-of-year math scores, even after controlling for prior achievement and student demographics. Each usage metric—minutes spent, units completed, days of engagement, and fidelity-level usage—predicted better performance, while months with zero usage predicted lower scores.
- **Equity and Moderation:** The positive association between usage and achievement was largely consistent across gender, race/ethnicity, and English Language Learner status. Grade level moderated the relationship, with older students deriving slightly larger benefits from additional engagement.

Conclusions and Recommendations

The findings of the current study indicate that regular use of Beast Academy Online supports mathematics achievement for high-ability elementary students, a group often overlooked in remediation-focused recovery efforts. **Based on its correlational design with statistical controls for selection bias, this study provides *Promising Evidence* under ESSA Tier 3.** To support effective implementation and promote positive outcomes, the UEPC recommends the following:

- **Professional Learning for Educators:** Teachers should receive training on integrating Beast Academy Online into instruction and differentiating content for high-ability students.
- **Student Goal-Setting and Progress Monitoring:** Educators should leverage the platform's data tools to set individualized goals, track progress, and maintain appropriate challenge levels.
- **Research-Practice Partnerships:** Establishing partnerships among researchers, educators, and developers can enhance implementation fidelity and maximize student outcomes.

2 | Introduction

Study Overview

As educational technology becomes increasingly embedded in K-12 classrooms, school districts across Utah have turned to digital learning platforms to support student achievement and personalize instruction. One such platform is **Beast Academy Online**, a digital learning program for math developed by **Art of Problem Solving** for students in elementary grades. Designed to promote problem-solving and conceptual understanding, the program presents content in a comic-book format. It is often used with students who are identified as gifted or who might benefit from enrichment beyond the standard curriculum (https://beastacademy.com/online).

To better understand the impact of Beast Academy Online on student outcomes, Art of Problem Solving partnered with the **Utah Education Policy Center (UEPC)** to conduct an independent research study in **Davis School District**. The district, located in Farmington, Utah, is large and suburban, and includes 63 elementary schools. The study focuses on the mathematics achievement of students from 12 of these elementary schools who used the Beast Academy Online platform during the 2024-2025 academic year.

This research contributes to a growing body of evidence on the role that digital learning tools can play in supporting student learning in public school settings, where implementing differentiated instruction has been a persistent challenge. The urgency for effective solutions has been amplified in the wake of the pandemic, which exacerbated pre-existing achievement gaps between higher- and lower-performing students (National Assessment Governing Board, 2022; National Center for Education Statistics, 2024).

Research Questions

The UEPC's work was guided by two research questions:

- What is the relationship between student use of Beast Academy Online in Academic Year (AY) 2024-2025 and scores on end-of-year Acadience Math (K- 6th grade) and RISE (3rd – 8th grade) assessments in AY 2024-2025, controlling for prior performance?

- Does this relationship vary by characteristics of students (e.g., gender, race/ethnicity)?

Report Organization

The remainder of this report is organized into four sections:

- The **Background** section reviews existing research on the role that digital learning platforms may play in supporting student learning in mathematics.
- The **Methods** section describes the study's data sources, samples, and analytic strategy.
- The **Results** section presents key findings related to student use of Beast Academy Online and mathematics achievement.
- Finally, the **Conclusions and Recommendations** section summarizes implications of the findings and outlines potential directions for future research and practice.

3 | Background

Mathematics Performance and the Needs of Gifted Learners

Despite some evidence of recovery, national and state data continue to highlight concerns about mathematics achievement among K-12 students in the United States (National Science Board & National Science Foundation, 2024). Nationally, National Assessment of Educational Progress (NAEP) scores in 2024 were still below pre-pandemic levels (National Center for Education Statistics, 2024). Similar findings have emerged in Utah. In 2024, only 45.6% of students were proficient in math. This falls short of the Utah State Board of Education's 2022 target proficiency rate of 66.5% as well as the 2016 baseline proficiency rate of 49.7% (USBE Strategic Plan Implementation Update, 2024).

Educational recovery efforts following the pandemic have focused on students showing the greatest academic losses in mathematics (Fahle et al., 2023, 2024; Goldhaber et al., 2023; Kuhfeld, Soland, & Lewis, 2022). This emphasis is understandable, especially given growing evidence that lower-performing students are recovering more slowly than their higher-achieving peers (NAEP, 2024). However, an unintended consequence of this targeted focus is that high-ability and gifted students may be overlooked in both policy and practice. Despite not being labeled "at risk," these students also faced disrupted learning trajectories, reduced access to enrichment opportunities, and fewer advanced learning options during and after school closures (Alshehri, 2022; McCormick & Guilbault, 2022; Wolfgang & Snyderman, 2022).

Importantly, many of these challenges predate the pandemic. Research has long documented that high-ability students are frequently underserved in traditional classrooms where instruction, particularly in mathematics, often lacks the pace and depth needed to sustain their growth (National Center for Research on Gifted Education, 2019). In the current recovery climate, these students risk being further marginalized as schools prioritize remediation. Ensuring access to appropriately challenging and accelerated learning remains a critical, but often neglected, dimension of educational equity.

Technology-Enabled Learning Environments

In response to both longstanding inequities and pandemic-related learning disruptions, many schools have expanded their use of educational technology—including digital learning platforms—to supplement mathematics instruction. Compared to traditional one-size-fits-all approaches, technology-enabled learning environments offer the potential to create more personalized, learner-centered, and competency-based instruction (Brizard, 2023). These environments can be especially valuable for students whose learning needs fall outside the average range, including both those who need remediation and those who are ready for more advanced content.

A growing body of evidence supports the positive impact of educational technology on student achievement in mathematics. Several meta-analyses have found that digital learning tools can improve mathematics outcomes for K–12 students (e.g., Cheung & Slavin, 2013; Hillmayr et al., 2020; Kulik & Fletcher, 2015). In Utah, similar findings have emerged. Research conducted by the Utah Education Policy Center (UEPC) on students' use of digital learning platforms shows that students who use programs included in the Utah STEM Action Center's K–12 Math Personalized Learning Software Grant Program are more likely than non-users to demonstrate proficiency in mathematics, show academic growth, and

report stronger growth mindsets (e.g., Altermatt et al., 2025; Altermatt, et al., 2022; Altermatt & Rorrer, 2024a, 2024b)

Importantly, the impact of digital learning platforms varies across contexts and learners. Research suggests that the benefits of educational technology depend not only on the specific program but also on the quality and intensity of its use (Altermatt & Rorrer, 2024a, 2024b; Bernacki et al, 2021; Carbonari et al., 2024; Pane et al., 2017; Van Schoors et al., 2023; Thomas et al., 2024; Zheng et al., 2022). For gifted students in particular, platforms that provide access to advanced content, encourage deep conceptual thinking, and allow for accelerated pacing may help maintain engagement and support continued growth, especially in settings where differentiated instruction is difficult to implement consistently (Mukhamadiyeva & Hernández-Torrano, 2024).

4 | Methods

Data Sources

This study utilized data from two primary sources.

Usage Data from Beast Academy Online. The first source was Art of Problem Solving, which provided monthly platform usage data for students using Beast Academy Online between September 2024 and May 2025. Access to these data was made possible through a data-sharing agreement between Art of Problem Solving and Davis School District. The dataset included both student and school information, such as school identifier, instructor name, course name, student name, student login ID, and student grade level. Additionally, the files contained various usage metrics, including first and last login date, number of minutes of use, number of units completed, fidelity score, number of logins, and days of usage. To account for students missing in some months, zero values were imputed for usage-related metrics, ensuring that every student had complete monthly records.

Achievement and Demographic Data from Davis School District. The second source of data came from a separate data sharing agreement between the UEPC and Davis School District, allowing the district to share student achievement and demographic data for all 12 participating elementary schools. This dataset included current- and prior-year math assessment scores from Acadience Math and RISE assessments, providing a basis for evaluating student progress. Additionally, demographic information was provided, including race/ethnicity, English Language Learner (ELL) status, gender, and grade level. These data allowed for an examination of potential differences in student performance across demographic groups and enabled analyses of whether student characteristics moderated the relationship between Beast Academy Online usage and math achievement.

Samples

Two different analytic samples were used to maximize the use of available data. As described below, the "User Sample" provided a broad picture of usage trends, while the "Matched Sample" enabled rigorous examination of the relationships between Beast Academy Online usage and academic outcomes:

User Sample (n = 1,443). This sample included all students with any recorded Beast Academy Online usage between September 2024 and May 2025. It was used to analyze general usage trends, such as number of active users, average engagement levels (e.g., average usage and units completed) and shifts in engagement over time.

Matched Sample (n = 962). This refined sample was used for all analyses addressing the core research questions. It included only students who had both baseline and end-of-year math assessment scores and non-zero total Beast Academy Online usage. To ensure robust estimates, outliers in average usage were identified and removed using the interquartile range (IQR) method[1]. Math scores were standardized within grade and assessment type to allow comparability across tests. This sample formed the basis for bivariate analyses and multilevel regression models examining associations between Beast Academy Online usage and academic achievement.

[1] Outliers were identified using the interquartile range (IQR) method, which defines outliers as values that fall more than 1.5 times the IQR above the third quartile.

Table 1 summarizes key characteristics of both samples. The User Sample was larger and used primarily for descriptive analyses, while the Matched Sample allowed for achievement-based analyses. Notably, demographic information (gender, ELL status, and race/ethnicity) was only available for the Matched Sample through district records.

Table 1: Descriptive Characteristics of Analytic Samples

Demographics	User Sample	Matched Sample
Total N	1,443	962
Number of schools	12	12
Median Monthly Usage (mins)	29.1	35.9
Female (%)	N/A*	36.6
English-Language-Learner (%)	N/A*	1.6
White (%)	N/A*	87.7
Grade Distribution		
1st Grade (%)	7.8	8
2nd Grade (%)	9.4	9.6
3rd Grade (%)	16.6	18.5
4th Grade (%)	17.8	18.1
5th Grade (%)	19.5	21.8
6th Grade (%)	28.9	24

*Gender, English-Language-Learner status, and Race/Ethnicity were not available in the usage data received from Art of Problem Solving.

Usage Metrics

The UEPC created five usage metrics to capture both the quantity and consistency of student engagement with each program. These metrics were: average monthly usage, average monthly units completed, average monthly days of usage, number of months with fidelity-level usage, and number of months with zero usage. Table 2 provides definitions of each usage metric. Using multiple metrics allows us to capture a more nuanced view of student engagement.[2]

Table 2: Usage Metrics and Definitions

Usage Metric	Definition
Average Monthly Usage	Total number of minutes divided by the number of months.
Average Monthly Units Completed	Total number of units completed divided by the number of months.
Average Monthly Days of Usage	Total number of days a student used the software divided by the number of months.

[2] While we conducted analyses using all usage metrics, we present only a subset of figures for clarity. Descriptive trends focus on average monthly usage (minutes) as the most representative measure. Bivariate associations show three key metrics (usage, units, days) to illustrate consistent patterns, with others summarized in text. Regression models (Table 2) report all coefficients, and interaction analyses display only the average usage × grade level effect, as similar patterns were observed for other metrics.

Months with Fidelity-Level usage	Number of months in which a student met vendor-specific thresholds for meaningful or "fidelity" usage.
Months with Zero Usage	Number of months during the school year in which the student had no recorded usage.

Analysis Plan

The analysis followed a structured approach to examine the relationship between student engagement with Beast Academy Online and end-of-year math achievement.

In **Section 1** of the results, we explore **usage trends**, summarizing how students engaged with Beast Academy Online over time to provide context for the study. We then address the two research questions guiding the evaluation.

In **Section 2** of the results, we address **Research Question 1**—*What is the relationship between student use of Beast Academy Online in Academic Year (AY) 2024–2025 and scores on end-of-year assessments in AY 2024–2025, controlling for prior performance?* To do so, we conducted a two-step analysis:

- **Bivariate Associations**. We examined the bivariate relationships between different Beast Academy Online usage metrics and end-of-year math scores using generalized additive models (GAMs). These models offered a flexible way to visualize potential nonlinear associations between each usage metric (e.g., average minutes of usage, units completed, days of usage) and standardized math scores.

- **Multilevel Regression Models.** We then estimated multilevel regression models to assess whether usage metrics were significantly associated with end-of-year achievement, after controlling for students' prior math scores and demographic characteristics (gender, race/ethnicity, ELL status, and grade level). These models accounted for the nested structure of the data, recognizing that students were clustered within schools.

In **Section 3** of the results, we address **Research Question 2**—*Does the relationship between student use of Beast Academy Online and scores on end-of-year assessments vary by characteristics of students (e.g., gender, race/ethnicity)*? Here, we extended the regression models to include interaction terms. This allowed us to test whether the associations between Beast Academy Online usage and math achievement varied across student subgroups. Specifically, we examined moderation by gender, race/ethnicity, ELL status, and grade level, providing insight into whether the effects of Beast Academy Online usage differed across demographic groups.

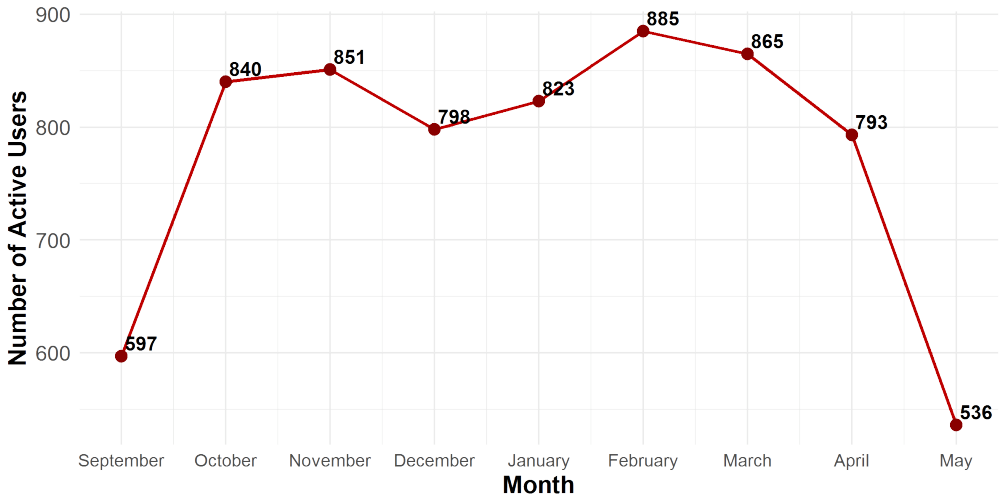
5 | Results

Usage Trends

Number of Active Users

Figure 1 presents the monthly trend in the number of active Beast Academy Online users (students with >0 minutes of use in a month) across the school year. Overall, the number of active users remained relatively consistent from month to month, with expected seasonal variations. Notably, there was a dip in December and another toward May, reflecting reduced usage during the winter holiday break and as the academic year concluded. Apart from these seasonal declines, engagement levels were fairly steady, indicating sustained program participation throughout most of the year.

Figure 1: Number of Active Users Each Month

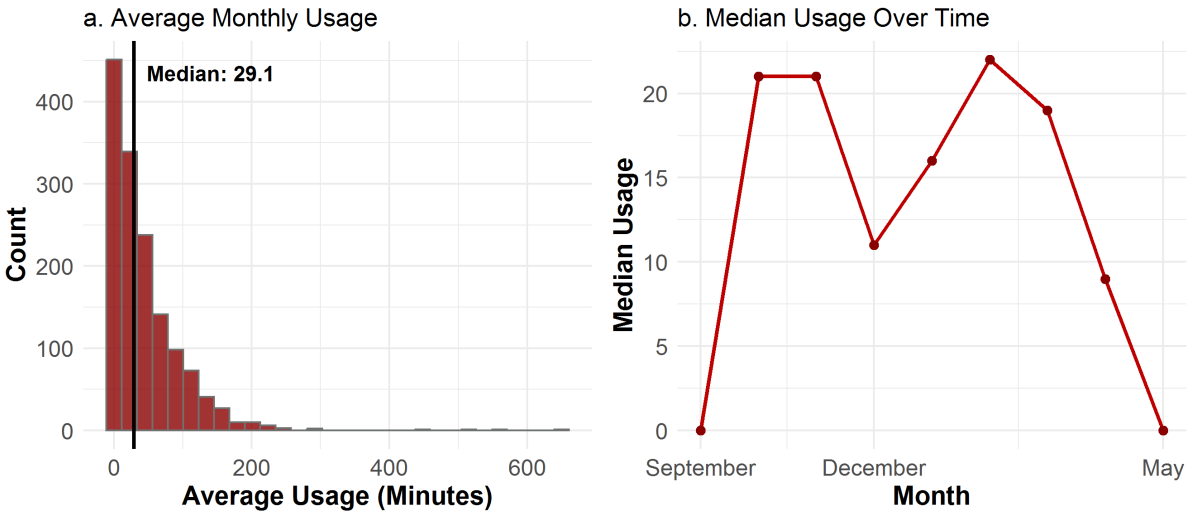


Usage Trends: Distribution of Average Monthly and Median Usage Over Time

Figure 2 provides two complementary views of student usage patterns:

- Figure 2a (Histogram of Monthly Usage Minutes) shows the distribution of students' average monthly usage minutes in a histogram. The distribution is positively skewed, meaning that while many students logged relatively modest amounts of time on Beast Academy Online, a smaller subset of students had very high usage, pulling the tail to the right. The median monthly usage was 29.1 minutes (indicated by the vertical reference line in Figure 2a), which corresponds to roughly half an hour per month. This low median suggests that at least half of the students used the platform for only about a half-hour or less each month, even though a few students engaged substantially more.
- Figure 2b (Median Usage Over Time) tracks the median usage by month over the course of the year. Median usage stayed in a low range throughout, with minor month-to-month fluctuations. In particular, the median minutes of use dipped in December and again in May, mirroring the pattern observed for active user counts. Overall, typical student engagement was modest and relatively stable, punctuated by slight declines during holiday and end-of-year periods.

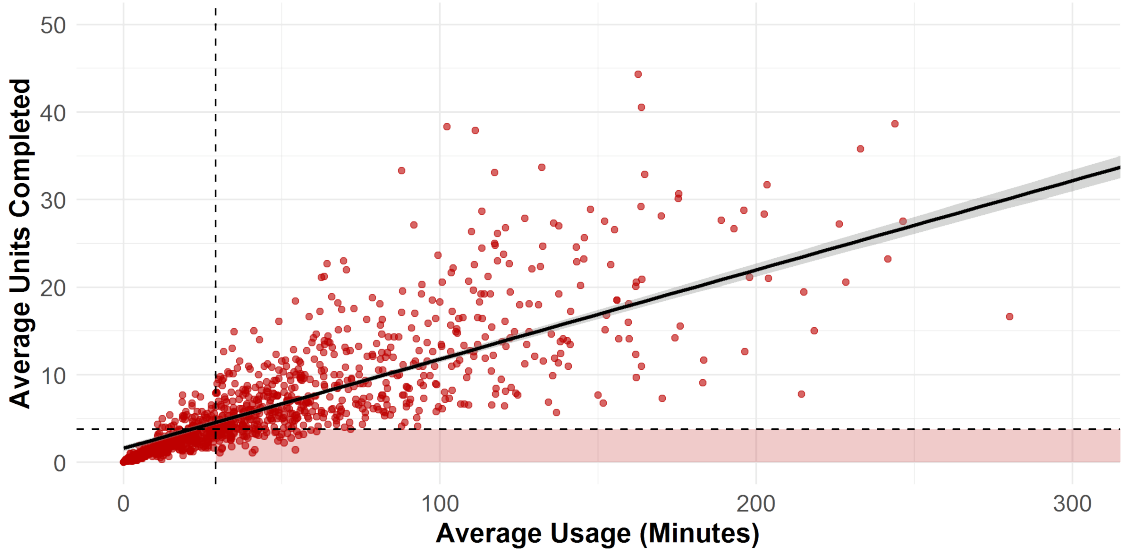
Figure 2: Usage: Distribution and Median Over Time



More Time More Progress

Figure 3 depicts the link between students' time on the platform and the amount of curriculum content they completed. Each point in this scatterplot represents a student's average monthly usage (minutes) and their average number of units completed per month. There was a strong positive correlation between these two measures ($r = .80$, $p < .001$), indicating that students who spent more time on Beast Academy Online tended to complete more instructional units. The shaded region of the figure highlights a small number of students who showed above-median usage but below-median units completed. This group was relatively small, meaning that the vast majority of students translated their time on the platform into clear progress.

Figure 3: Average Monthly Usage vs. Average Monthly Units Completed

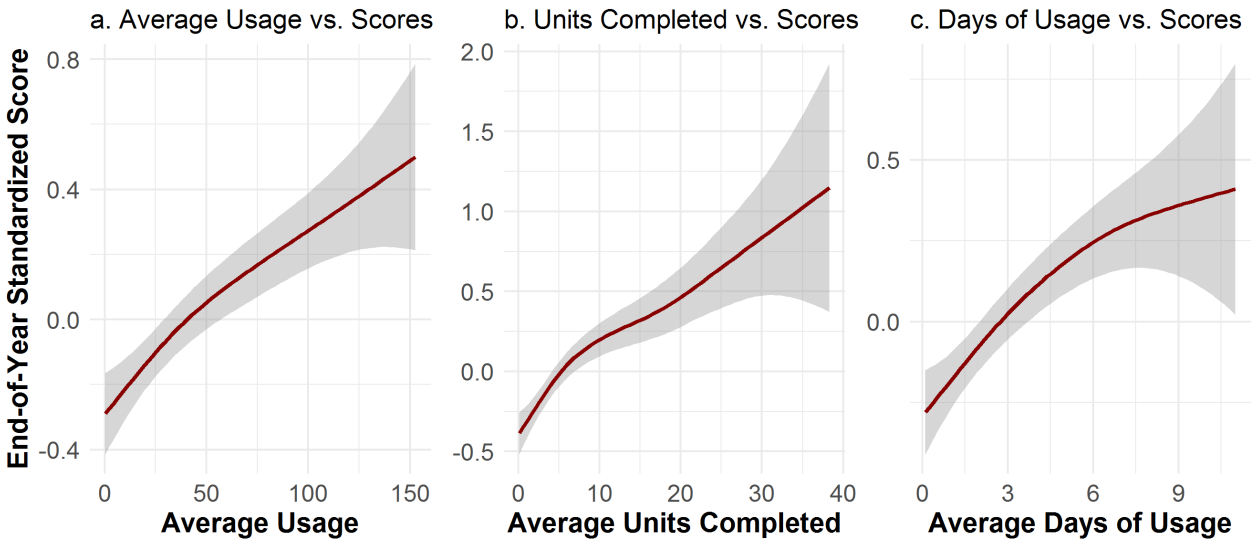


RQ #1: What are the relationships between student use of Beast Academy and end-of-year scores?

Bivariate Associations

To answer RQ #1, we first explored the simple relationships between each usage metric and students' end-of-year math achievement (standardized test scores) without any control variables. Each panel of Figure 4 plots a different aspect of usage (for example, average minutes per month, average units completed per month, average days of usage per month) against students' standardized math assessment scores. In each case, students with higher engagement on Beast Academy Online tended to have higher end-of-year math scores. The trend lines (derived from GAM smooths with 95% confidence bands) rise from left to right, indicating that greater usage is associated with better performance. These relationships appeared relatively linear within the observed range of data, with no indication of a plateau at higher usage levels. The shaded confidence intervals widen at the upper end of the usage distribution, reflecting greater uncertainty in the estimates due to fewer students reaching those higher engagement levels.[3]

Figure 4: Associations between Engagement and End-of-Year Scores



While these bivariate results are encouraging, they do not account for pre-existing differences between students. Therefore, we next conducted multivariate analyses to see if these relationships held after controlling for students' prior achievement and background characteristics.

[3] In addition to the metrics depicted in Figure 4, other usage indicators not shown in the figure demonstrated similar patterns. For instance, the number of "fidelity" usage months (months in which a student met a recommended usage threshold) was positively correlated with end-of-year scores, whereas the number of zero-usage months was negatively correlated with scores.

Regression Analysis

To test the link between Beast Academy Online usage and math achievement more rigorously, we estimated a series of regression models that controlled for students' baseline math ability and demographics. In these linear mixed-effects models, each student's end-of-year standardized math score was predicted from one usage metric, controlling for their baseline math score as well as student-level characteristics (grade level, gender, race/ethnicity, and ELL status). We also included random intercepts for schools to account for the nesting of students within schools. Table 3 summarizes the key results from five separate models, each focusing on a different usage variable. Across all models the Beast Academy usage measures remained significant predictors of end-of-year math performance even after controlling for students' initial scores and demographics. For example, average monthly usage (minutes) predicted higher achievement ($b = 0.004$, $SE = 0.001$, $p < .001$), such that a student who used the platform 100 minutes more per month than a peer would be expected to score about 0.4 standard deviation higher at year's end. Conversely, the number of zero-usage months was a negative predictor ($b = –0.027$, $p < .01$), indicating that each month without use was associated with approximately a .03 standard deviation lower end-of-year math score. While the effect sizes were modest, the consistency of results across multiple measures indicates that greater engagement with Beast Academy Online was reliably associated with higher end-of-year math achievement.

Table 3: Fixed Effects Estimates from Separate Linear Mixed Models for Each Usage Metric Predicting End-of-Year Standardized Scores

Usage Metric	Estimate	SE
Average Usage	**0.004*** **	0.00
Average Units Completed	**0.026*** **	0.00
Average Days of Usage	**0.054*** **	0.01
Fidelity	**0.080*** **	0.02
Zero-usage months	**-0.027** **	0.01

*** $p < .001$, ** $p < .01$

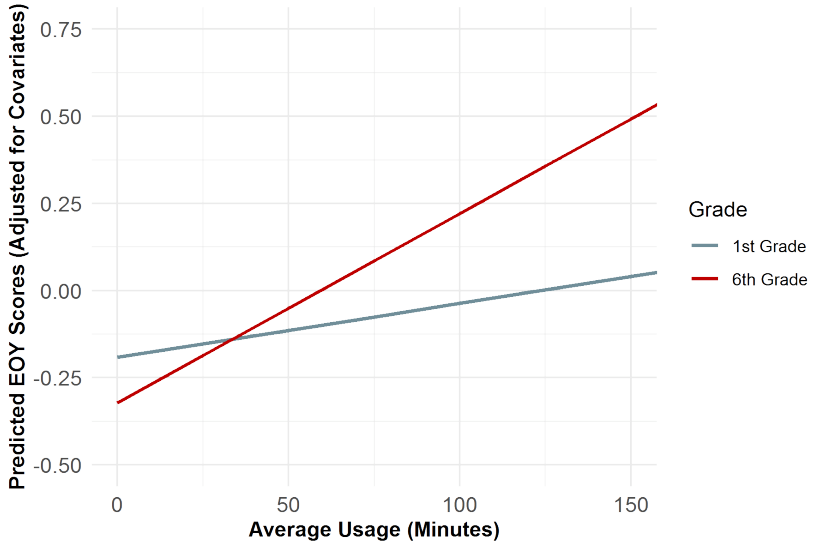
RQ #2: Are these relationships moderated by the characteristics of students?

To examine whether the relationship between Beast Academy Online usage and end-of-year math achievement varied across student subgroups, we tested interactions with gender, English Language Learner (ELL) status, race/ethnicity, and grade level. Statistically, this involved adding interaction terms to the regression models for each usage metric × subgroup combination.

Most demographic interactions were not significant, indicating that the positive association between usage and achievement was broadly similar for boys and girls, students from different racial/ethnic backgrounds, and English learners and non-ELL students alike. However, we did find evidence that grade level moderated the relationship between usage and achievement for some of the usage measures. In particular, interactions between grade level and three metrics – average monthly usage minutes, average units completed, and average days of usage – were statistically significant ($p < .05$). This means that the strength of the usage-achievement link varied by students' grade in school.

Figure 5 illustrates one of these moderation effects, depicting the relationship between average monthly usage and end-of-year math scores for students in different grades. As shown in the figure, the slope of the line relating usage to achievement is steeper for older students (i.e., 6th graders) than for younger students (i.e., 1st graders). In practical terms, additional time spent on Beast Academy Online yielded a larger increment in test scores for students in higher grade levels, whereas the gains associated with increased usage were more modest for the younger students. All grade levels still showed a positive correlation between usage and performance—even the younger students benefited from more usage—but the advantage gained per unit of usage was amplified in the upper elementary grades.

Figure 5: Average Usage and Grade Level Interaction



6 | Conclusions and Recommendations

Conclusions

This report examined the relationship between students' use of Beast Academy Online, a mathematics learning platform specifically designed to meet the learning needs of high-ability students. The findings indicate a positive association between regular engagement with the platform and improved mathematics performance. These results suggest that when gifted students are provided with appropriately challenging, self-paced, and enriched online learning experiences, they are more likely to make meaningful academic progress.

Recommendations

For districts considering the new adoption, continued use, or broader implementation of Beast Academy Online to support high-ability learners in mathematics, the Utah Education Policy Center (UEPC) offers the following recommendations to support effective implementation and promote positive student outcomes:

1. **Provide focused professional learning for educators.** To maximize impacts, teachers should have access to high-quality professional learning opportunities that focus on integrating Beast Academy Online into their instructional practices. Training should cover not only technical aspects of platform use, but also strategies for aligning online content with existing curricula including approaches to differentiate instruction for high-ability learners. Ongoing supports, including through professional learning communities, can help educators refine their use of the platform over time.

2. **Support student goal-setting and use of progress data**. Building on the UEPC's prior research on "best practices" for math learning software implementation (e.g., Altermatt & Rorrer, 2024a, 2024b; Altermatt, Yildiz, & Rorrer, 2025), educators should work with students to set individualized learning goals and monitor student progress within the platform. Teachers should also use Beast Academy Online's built-in data tools to identify students' strengths and areas for growth and maintain appropriate challenge levels to ensure students stay engaged and motivated.

3. **Consider a Research-Practice-Industry-Partnership (RPIP) to strengthen implementation and maximize impact**s. Art of Problem Solving and districts may benefit from establishing a research-practice-industry-partnership (RPIP) with an external research organization—like the UEPC—to systematically study and refine the implementation of Beast Academy Online (see https://digitalpromise.org/rpip/). In this approach, researchers, educators, and platform developers work together through iterative feedback cycles, co-designing research questions, conducting implementation studies, and using data to continuously improve both the tool and instructional practices. An RPIP can provide ongoing support for evaluating both the fidelity of implementation and the program's effects on a range of student outcomes, including academic performance, self-efficacy, and growth mindsets.

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