An Early Look at ACT Academy Usage and Effectiveness

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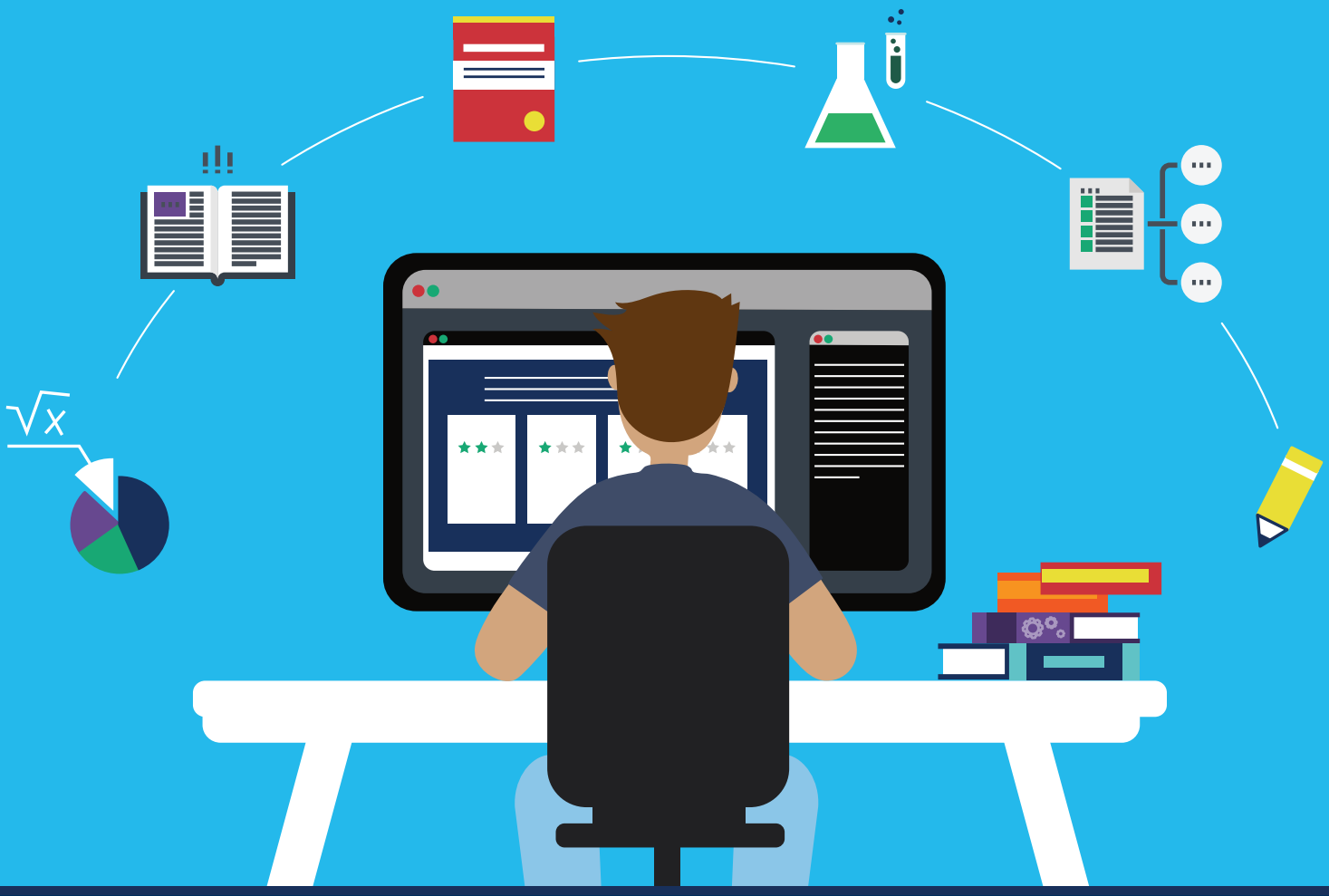

ACT®

Research Report
2019-5

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SUMMARY

ACT Academy was launched in March 2018 as a free online resource to help students improve their academic skills and prepare for the ACT test. This study provides an early look at ACT Academy usage and its effects on ACT test scores.

We found that moderate usage (e.g., 6 hours) of ACT Academy's quizzes and practice tests leads to an improvement in ACT test scores of 1-2 points. However, most students have not spent enough time on the platform to reap the benefits.

We also found that the number of ACT Academy users has increased steadily over time, and that female, Asian, and higher-achieving students are somewhat more likely to use ACT Academy.

SO WHAT?

The results suggest that ACT Academy can be an effective and efficient tool to improve academic skills important for college and careers. ACT Academy can have a greater impact on college readiness if more students are aware of it and invest the time needed to benefit from it.

NOW WHAT?

The study only examined usage of assessments (quizzes and practice tests) within ACT Academy, and did not analyze how item responses or usage of the online learning resources related to ACT test score gains. Additional research is needed to understand what usage patterns result in the greatest gains.

Contents

Introduction

What is ACT Academy: A Learning Platform, Test Preparation Resource, or Both?

ACT® Academy™ was launched on March 22, 2018 as a free online resource to help students improve their academic skills and prepare for the ACT® test. It provides individualized learning plans to help students improve their skills in four subject areas (English, reading, math, and science) tested on the ACT. However, it is also possible for students and teachers to incorporate the learning resources available in ACT Academy into instruction in the four subject areas more broadly. Therefore, it might be useful to consider the similarities and differences between conventional notions of learning and test prep.

Learning can be broadly defined as "the process of acquiring new or modifying existing knowledge, behaviors, skills, values, or preferences and may involve synthesizing different types of information" (Schacter, Gilbert, Wegner, & Hood, 2011). Students may acquire new knowledge or modify existing knowledge when using ACT Academy to prepare for the ACT. Yet, for many educators, particularly classroom teachers, test preparation is not what comes to mind when they think of "learning" or a "learning platform." Instead, test preparation often assumes that students have already learned or at least encountered concepts previously; therefore, the goal of most test prep is to review content and shore up understanding of concepts as opposed to teaching them from scratch. In addition to reviewing content likely to be covered on a test, test prep entails practicing skills needed to demonstrate knowledge in the format of the test (Crocker, 2006).

While ACT Academy may primarily serve a test prep role, it can also be regarded more broadly as a learning tool. Students may encounter entirely new concepts when using ACT Academy or may receive new instruction on previously introduced concepts. If ACT Academy is an effective learning tool, we would expect it to not only result in higher ACT test scores, but for the learning gains to also transfer to other external outcomes (e.g., performance in subsequent high school and college courses, performance on other assessments) and skills (e.g., critical thinking, reasoning). Alternatively, if ACT Academy is only effective as a test prep tool, we would not necessarily expect positive effects on external factors. As part of this study, we examine whether use of ACT Academy leads to higher ACT score gains. Future studies will examine the effect of ACT Academy usage on other outcomes, such as classroom performance, to determine the extent to which learning gains transfer beyond the ACT.

Features of ACT Academy

When users arrive at the ACT Academy website, they have either the option of anonymously searching and viewing resources accessible via the *Resource Library,* or they can sign in/register to access the quizzes, practice tests, and other features of ACT Academy. There are four primary sections of the ACT Academy interface displayed at the top of the screen: *Dashboard*, *Resources*, *Progress*, and *Tips & Strategies*. A fifth area of ACT Academy, *Assignments*, is available for students who are members of an ACT Academy class set up by a teacher.

Dashboard

The *Dashboard* provides users an overview of the progress made towards mastery in each of the four subject areas by displaying one to three green stars and indicating the number of quizzes completed in each area. On the *Dashboard* screen, users can scroll down to access a daily study plan with selected learning resources and a quiz to complete each day. Students who have already taken the PreACT® or ACT have the option of entering their *reporting category* scores, which indicate how a student performed on specific skill areas within each of the four subject areas. The reporting categories correspond to the domains used to group the ACT College and Career Readiness Standards.[1] Math contains seven reporting categories, while science, English, and reading each contain three reporting categories. Examples include *Number & Quantity* for math and *Production of Writing* for English.

Resources

The *Resources* section presents students with a selection of learning resources organized by topic under each of the four subject areas. ACT Academy includes both free resources (Open Educational Resources, or OERs) and links to premium resources students can purchase. Premium resources are mostly homework assignments, while the OERs consist primarily of video-based, mini-lecture explanations of concepts and illustrated demonstrations (79% of all learning resources). The resources database also includes interactive simulations (1%) where students derive answers to problems by manipulating inputs to simulated functional systems, game-based activities (2%), assessments (0.34%), lesson plans (0.41%), audio (3%), and other (14%). Each video resource includes a description of the contents of the video with links to related resources. At the end of some videos, there is a link to an assessment tied to the content of the video. These assessments are separate from the ACT-based assessments (i.e., ACT Academy quizzes, ACT practice tests) featured in the *Dashboard* and *Progress* sections of ACT Academy.

Progress

The *Progress* section provides a detailed view of the quizzes available for each topic/reporting category with multiple quizzes available for each category. It also includes a tab for ACT practice tests.

ACT Academy Quizzes

The quizzes are short, consisting of 5-10 multiple choice questions. They are organized by the same topics used as reporting categories on the PreACT and ACT tests. See Appendix Table A1 for a list of the available quizzes. For each quiz in the *Progress* view, students see the date the quiz was taken, their score, their level of mastery (1 to 3 stars), a link to start the quiz (if quiz has not been taken), or links to retake the quiz or practice on questions answered incorrectly (if quiz has already been taken).

Quiz items and learning resources are all tagged at the most granular level of the ACT Holistic Framework (Camara, O'Connor, Mattern, & Hanson, 2015) hierarchy–KSAOs (knowledge, skills, abilities, and other characteristics). ACT Academy utilizes the *Recommendations and Diagnostics (RAD) API* for

assessing at this level of each item in a quiz or practice test, and those estimates are propagated up the hierarchy to the reporting category level. ACT Academy utilizes this diagnostic calculation for determining level of mastery and relies on the RAD API to deliver personalized selections of learning resources.

After completing a quiz, users are presented with a feedback screen displaying the percentage of questions answered correctly at the top. The questions are listed below along with an indicator of whether the response selected was correct. Additionally, the item responses are sent to the RAD API, and the correct/incorrect responses are incorporated into the student's diagnostic model. These probabilistic values are used for determination of any updates to the star values displayed in Academy (cutoff values are applied). For incorrect responses, links are provided to resources that help users develop the targeted skills. Users can view the response options along with how they responded to a given question by clicking the "Show full Q&A" link. At this point, users can either view one or more of the recommended resources or they can close the results window to return to either the *Dashboard* or *Progress* screen to retake the same quiz or to select a different one.

ACT Practice Tests

In addition to tabs for each of the four subject areas showing the quizzes, the *Progress* section also includes a tab for ACT practice tests. Two practice tests are available for each subject area, with the number of questions matching a full-length ACT test (math = 60; science = 40; English = 75; reading = 40). Practice tests use the same question formats and some of the same reading passages as quizzes, and the feedback provided to users at the end of practice tests is the same as for quizzes. The practice test tab shows a student's score on each practice test completed, using the 1-36 ACT score scale. These scores serve as a progress monitor and as a prediction for performance on an actual ACT test.

Tips & Strategies

The *Tips & Strategies* section provides a quick start guide for using ACT Academy, as well as several ACT test-taking strategies (e.g., pacing yourself, reading the directions for each question carefully, and answering every question). This section also includes tips specific to each subject area including descriptions of question formats and things to look for in each question (i.e. "be aware of questions with no underlined portions").

Assignments

Students who are part of an Academy class will see an additional section called *Assignments*, which includes resources and assessments assigned by their teacher. Teachers can create assignments from scratch or based on a reporting category (e.g. *ACT Algebra 1*). For each assignment, students see the date it was assigned, the due date if one was set, and the completion status.

Navigating ACT Academy

In the quick start guide under *Tips and Strategies*, students are encouraged to develop their own path for navigating the assessments and learning resources offered by ACT Academy. General strategies for navigating ACT Academy could include:

- Taking quizzes and/or practice tests and trying to identify misconceptions by delving into incorrect responses, without watching video lessons.

- Taking quizzes and/or practice tests to identify deficient skills and then watching video lessons that address those skills.
- Scrolling through *Resources* and watching video lessons, with or without subsequently taking quizzes or practice tests.
- Following the daily plan presented in *Dashboard*, where students are encouraged to practice at least 30 minutes per day, 2-3 days per week.
- Completing assignments that are given by an instructor.
- Some combination of the above approaches.

In this study, we do not attempt to identify the strategies used nor try to understand which strategies are most effective. However, these are areas of study we recommend for future research.

Current Study

In this paper, we provide an early look at how students are using assessments within ACT Academy through the first 15 months of the platform's existence and whether this usage results in higher ACT scores. Using a subset of the data generated by the platform, this initial investigation will form the basis for more extensive future research looking at patterns of use as they relate to ACT score gains and other learning outcomes.

The ACT Academy platform records user performance when taking quizzes and practice tests and access and interaction with learning resources in the ACT Academy database. The current study is limited to assessment completion data, which includes a user identifier, start date, end date, and assessment name from which we can identify the subject area (English, math, reading, or science) and, for ACT quizzes, the reporting category (e.g., Knowledge of Language). Other assessment-related data, such as item responses and test scores, were not available to be used in this study.

The study is limited to assessment use as the sole measure of engagement with the ACT Academy platform. Other aspects of engagement, such as use of video lessons, are not examined. Because ACT Academy quizzes and practice tests are important components of the learner experience that drive Academy's recommendation and diagnostic engine, we believe that assessment use is a reasonable proxy for overall engagement with ACT Academy.

Research Questions

The study addresses four research questions:

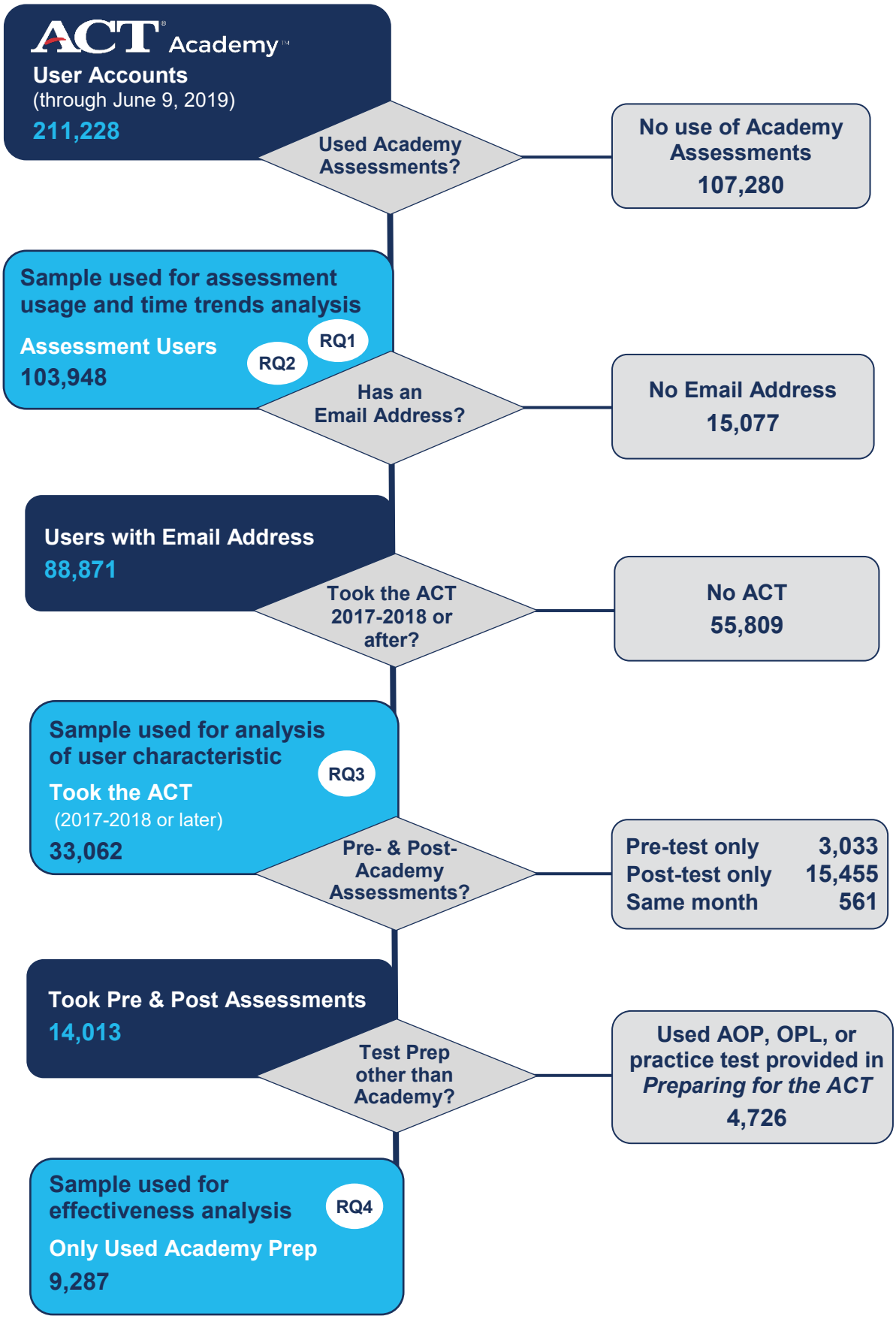
- RQ1: How has usage of ACT Academy's assessments trended over time?
- RQ2: Does usage vary across different types of ACT Academy assessments?
- RQ3: What are the demographic and academic characteristics of ACT Academy assessment users?
- RQ4: Does use of ACT Academy assessments lead to higher ACT test scores?

Methods and Findings

The study timeframe covers the launch of ACT Academy (March 2018) through the June 8, 2019 ACT test administration. There were over 211,000 ACT Academy user accounts, which include student, teacher, and parent accounts. Beginning with all ACT Academy accounts, Figure 1 shows how exclusion criteria are applied sequentially to arrive at the samples used to address the research questions. The exclusion criteria include:

- No use of ACT Academy assessments (n=107,280). After this step, we have the sample used to address RQ1 and RQ2 (n=103,948).
- No email address registered with an ACT Academy account (n=15,077). Email address is used in the next step to match to ACT test records.
- No match to ACT test records (n=55,809). Students only have a match to an ACT test record if they took the ACT during the 2017-2018 academic year or later, provided an email address that was the same as the email address used for ACT Academy, and had an ACT test record that was not restricted for use.[2] For students who had an email address matching one or more ACT test records, we also attempted to obtain PreACT test records. The remaining sample is used to address RQ3 (n=33,062). Of note, the only source of data for demographic and academic characteristics of the sample is ACT test records (background data are not currently collected by ACT Academy).
- No pre-post ACT tests with intervening use of ACT Academy assessments (n=19,049). A pre-post analysis design gives us greater confidence that we can measure the effect of ACT Academy assessment usage because students' initial achievement level is controlled. While 33,062 students have a matching ACT test record, only 14,013 students tested multiple times and used ACT Academy between the two tests.[3]
- No use of other ACT test prep products (ACT® Online Prep, ACT® Kaplan® Online Prep Live) and no use of the practice test provided in the *Preparing for the ACT* booklet. By excluding students who are known to have used other test prep products, we can be more confident that any differences in ACT score gains are more likely due to ACT Academy usage and not other forms of test prep. After this step, we have the sample used to address RQ4 (n=9,287).

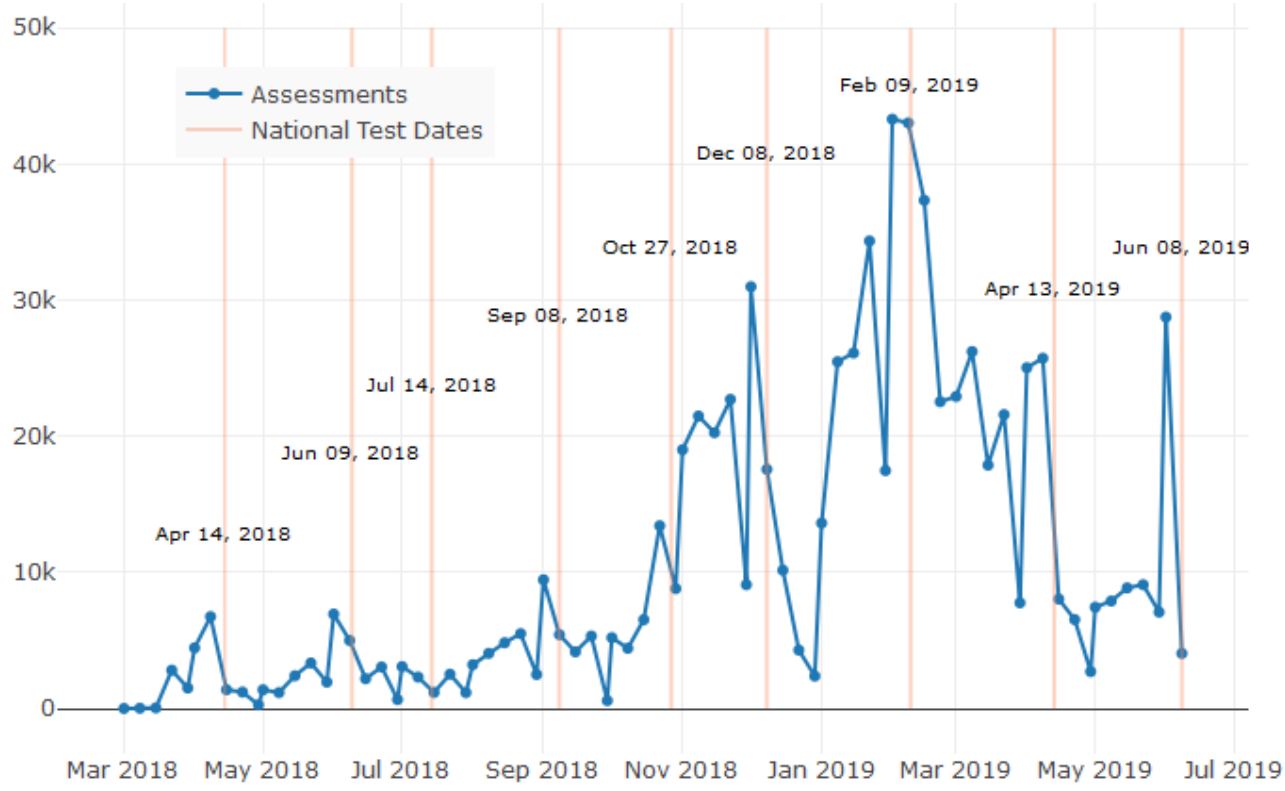
Figure 1. Exclusion Criteria Applied to Generate Samples for Addressing Research Questions



RQ1: How has usage of ACT Academy's assessments trended over time?

We addressed this research question (RQ1) by examining assessment completion data aggregated by week. As seen in Figure 2, usage typically spikes shortly before national test dates with the largest spikes occurring before the October, December, February, April, and June test dates. The steep drop after the December 8, 2018 test date suggests there is a lull in test preparation activity among students during the winter break and holiday season. The spikes in the number of assessments completed consistently seen in the final week or two before a test date suggest that many students are "cramming" for the ACT test.

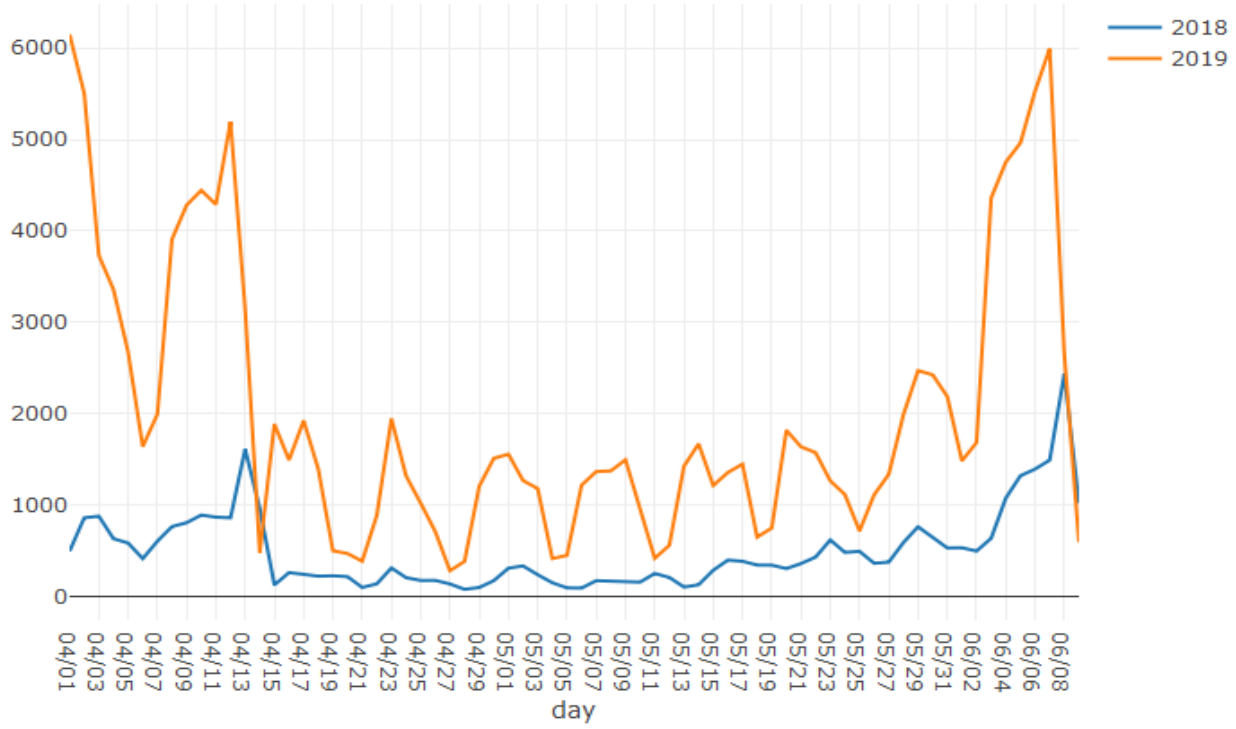
Figure 2. Number of ACT Academy Assessments Completed by Week



A comparison of spikes in activity (Figure 2) just before the April and June national test dates for 2018 and 2019 suggest an approximate four-fold increase in Academy use over the past year.[4] For the April test dates, the number of assessments completed jumped 396% from 6,751 in April 2018 to 26,735 in April 2019. The same comparison for the June 2018 to June 2019 test dates saw the number of assessments completed increase by 415% from 6,937 to 28,758.

In order to examine the overlapping months for the two years, we graphed the assessments completed by day (instead of by week as seen in Figure 2) for the April 1 to June 9 period for both 2018 and 2019 (see Figure 3 below). In addition to the magnitude of the spikes before national test dates, it is worth noting that the number of assessments completed on a daily basis for 2019 follows a similar pattern as is seen in 2018, though amplified considerably. Each peak represents the school week, and the valleys are the weekend. This may indicate that schools are the primary drivers of ACT Academy use, or that students are less motivated to use ACT Academy on the weekends. Additional research is needed to examine use by day and hour, which could inform how much Academy is being integrated into the school day.

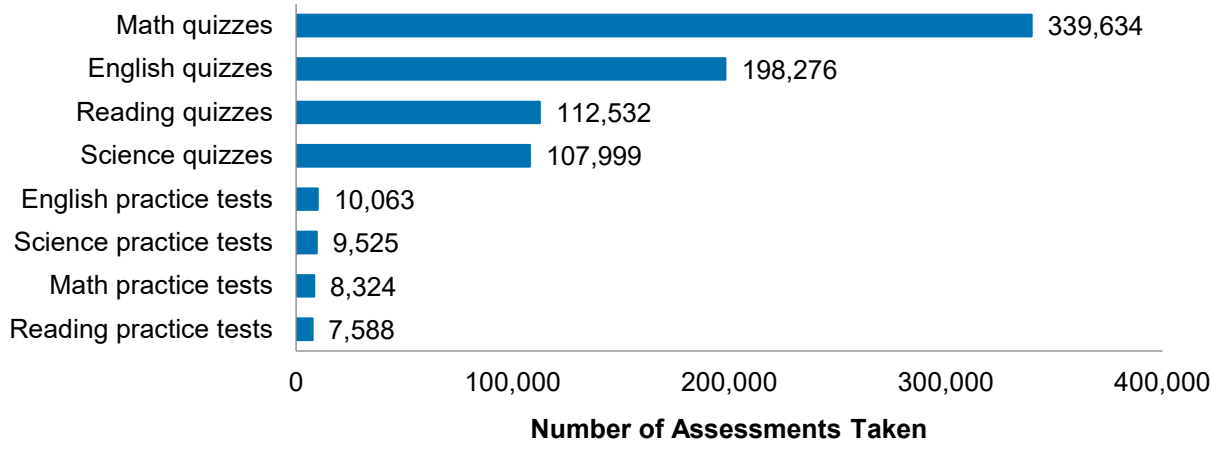
Figure 3. Comparison of Number of ACT Academy Assessments Completed Between April 1 and June 9 for 2018 and 2019



RQ2: Does usage vary across different types of ACT Academy assessments?

We addressed this research question (RQ2) by presenting usage statistics for each ACT Academy assessment. Overall, there are 127 assessments, including eight practice tests (two for each subject area) and 119 quizzes (16 reporting categories, and 2-19 quizzes per reporting category). Appendix Table A1 lists the number of times each assessment was taken, the number of unique students who took each assessment, and the median assessment time. A total of 793,941 assessments were taken, with quizzes taken far more often than practice tests (Figure 4).

Figure 4. Number of ACT Academy Assessments Taken, by Subject Area and Assessment Type



For each subject area, the number of quizzes taken dwarfed the number of practice tests taken. Students may have chosen quizzes over practice tests because they are much shorter. The median time to take a practice test ranged from 40.0 to 90.9 minutes (mean=57.2 minutes), while the median time to take a quiz ranged from 1.4 to 12.6 minutes (mean=4.6 minutes).

The most quizzes were taken in math. There are a number of possible drivers for this. Perhaps more math quizzes are completed simply because math offers more quizzes (43) relative to English (37), reading (33), and science (7). Or, students may be more motivated to improve their math skills or may believe that math is more amenable to review and practice. It is also possible that since math is listed first in Academy (the tab opened by default in the *Progress* section), students just start with what is presented to them first. The number of practice tests taken was more consistent across subject areas, with the most practice tests taken in English.

Usage varied extensively across the 119 quizzes, ranging from 817 for *Conventions of Standard English, Quiz 12* to 58,484 for *Math Number and Quantity, Quiz 8*. From Table A1, we see that the quiz with the highest number for each reporting category was taken the most. For example, for *Conventions of Standard English*, Quiz 19 (the last quiz for this reporting category) was taken 16,786 times, whereas Quiz 1 was taken 5,867 times. Why is the last quiz for a reporting category being completed disproportionately more than others? Possibly, this is part of a review strategy: students are choosing or teachers are assigning the last quiz, believing that the quiz number (which is presented as a Roman numeral in Academy) indicates the quiz level, and students wish to test themselves at the highest level to determine if more work is needed.

Another reason for variation in usage across assessments is that some assessments have been available longer on the ACT Academy platform. While ACT Academy was launched in March 2018, the second practice tests were first available in September 2018, and several quizzes were introduced in July 2018 and September 2018.

RQ3: What are the demographic and academic characteristics of ACT Academy assessment users?

We addressed this research question (RQ3) using the sample of 33,062 students who took ACT Academy assessments and were matched to at least one ACT test record. Note that this is an underestimate of the actual number of students who used ACT Academy and took the ACT test because:

- Not all students who used ACT Academy took an ACT Academy assessment, and so were not candidates for matching.
- Not all students who took an ACT Academy assessment provided an email address.
- Not all students who take the ACT test provide an email address (or may provide an email address different than what they use for ACT Academy), so cannot be matched.
- Not all ACT test records are candidates for matching because of data use restrictions from contracts and state data privacy laws.

In this section, we compare the Academy sample to the ACT-tested population, using the 2018 ACT-tested high school graduating class (ACT, 2018) as the population. We compare the Academy sample to the population on gender, race/ethnicity, parent education level, average ACT Composite score, average high school GPA, and school control (Table 1).

Table 1. Student Characteristics of 2018 ACT-Tested Graduating Class and Academy Assessment Users with a Matched ACT Test Record

Characteristic	2018 ACT Grad Class	Academy Users with ACT Match
Number of students	1,914,817	33,062
Number of high schools	25,765	10,566
Gender, %		
Female	51.8	64.4
Male	46.7	35.5
Missing	1.5	0.1
Race/ethnicity, %		
African American	12.7	13.7
Asian	4.8	11.4
Hispanic	16.1	14.0
Other	5.6	5.5
White	52.1	51.1
Missing	8.8	4.3
Parent education level,[5] %		
No college (1-2)	16.1	14.4
Some college (3-5)	18.5	18.5
Bachelors (6)	21.9	27.5
> Bachelors (7-8)	18.5	28.3
Missing	25.0	11.4
Average parent education level[6]	5.0	5.4
Average ACT Composite score	20.8	23.4
Average high school GPA	3.31	3.62
School control, %		
Non-public	9.8	12.2
Public	88.2	79.4
Foreign	0.0	2.0
Missing	2.0	6.4

The 33,062 students who have used ACT Academy and have been matched to at least one ACT test record come from over 10,000 high schools across the United States and other countries. Relative to the ACT-tested population, the Academy sample has a larger concentration of female (64% vs. 52%), Asian (11% vs. 5%), and African American students (14% vs. 13%). The Academy sample has a smaller concentration of Hispanic (14% vs. 16%), White (51% vs. 52%), and students who did not provide their race/ethnicity (4% vs. 9%).

Relative to the general population of ACT-tested students, Academy participants were more likely to report their parents' education levels (89% vs. 75%). Among students who reported parent education level, it tended to be slightly higher for students in the Academy sample relative to the population.

Academy students had higher academic achievement than the general population of ACT-tested students. Mean ACT Composite score (using most recent score) was 23.4 for the Academy sample,

compared to 20.8 for the population. Mean high school GPA, based on self-reported course grades, was 3.62 for the Academy sample and 3.31 for the population.

While most Academy students (79%) attended public high schools in the United States, relative to the population, they were more likely to attend non-public schools (12% vs. 10%) or attend a high school with unknown affiliation (6% vs. 2%). A small share of Academy students (2%) attended high school outside of the United States. Appendix Table A2 lists the number of identified ACT Academy users with ACT test records, by state. The states with the most ACT-tested Academy users include Texas (n=2,371), Florida (n=2,270), California (n=1,749), Tennessee (n=1,569), and Ohio (n=1,507). As expected, the number of ACT-tested Academy users in a state is highly correlated with the number of ACT-tested high school graduates in a state (r = .89).

RQ4: Does use of ACT Academy assessments lead to higher ACT test scores?

We addressed this research question (RQ4) by comparing ACT score gains for Academy users to those of similar students who did not participate in ACT Academy. This analysis is restricted to the 9,287 students who participated in ACT Academy assessments between PreACT/ACT tests, in addition to a large comparison group of students from the same high schools who did not use ACT Academy. To be in the comparison group, students must have:

- Taken the ACT at least twice between April 2018 and June 2019, with at least one month between tests. Note that the PreACT test could be used in place of the ACT for the pretest.
- No use of ACT Online Prep (AOP), ACT Online Prep Live (OPL), or ACT Academy using an account with the same email address used to register for the ACT. Note that these exclusion criteria cannot be executed with 100% accuracy because some students may have used ACT test prep resources with a different email address than that used for the ACT test.
- Must not have responded “Yes” to two questions regarding test preparation prior to taking the ACT: “Did you prepare for the ACT test using any test preparation materials (for example, *The Official ACT Prep Guide*, other study guides, online materials, practice tests, tutors, or test prep courses)?” and “Did you prepare for today's test using ACT's free, full-length practice test found in the *Preparing for the ACT* booklet?” Note that students who are missing responses to these questions, which are only asked during national ACT test administrations, are not excluded.
- Must have attended the same high school as at least one of the ACT Academy participants.

Overall, 326,599 students met these criteria and are included in the comparison group.

Measuring usage of ACT Academy assessments

Level of usage of ACT Academy assessments can be measured multiple ways, including total number of assessments taken, total amount of time spent on assessments, total number of quizzes taken, total number of practice tests taken, and total number of days with at least one assessment. We chose to focus on the amount of time spent on assessments because we thought it was a reasonable proxy measure for overall commitment to, and engagement with, ACT Academy. Time spent on assessments self-weights assessments with different time commitments. For example, students who take a practice test generally spend more time than students who take a quiz and thus should have a greater measure of assessment usage.

For each assessment event, our data set included start and end times, which we used to calculate assessment duration. In many cases, students had assessment events that were unrealistically long (e.g., a practice test that took two weeks to complete). In these cases, the student likely paused the assessment and completed it on a later date, and so the assessment duration was not an accurate measure of their time on task. Therefore, we could not simply use the sum of all assessment durations as the measure of total assessment time. Instead, we first identified a reasonable upper bound for the duration of each type of assessment. Then, if a student's assessment time exceeded the upper bound, the assessment time was considered an outlier, and we only credited the student with the upper bound as their assessment time.

To calculate an upper bound of assessment time for each assessment, we followed these steps:

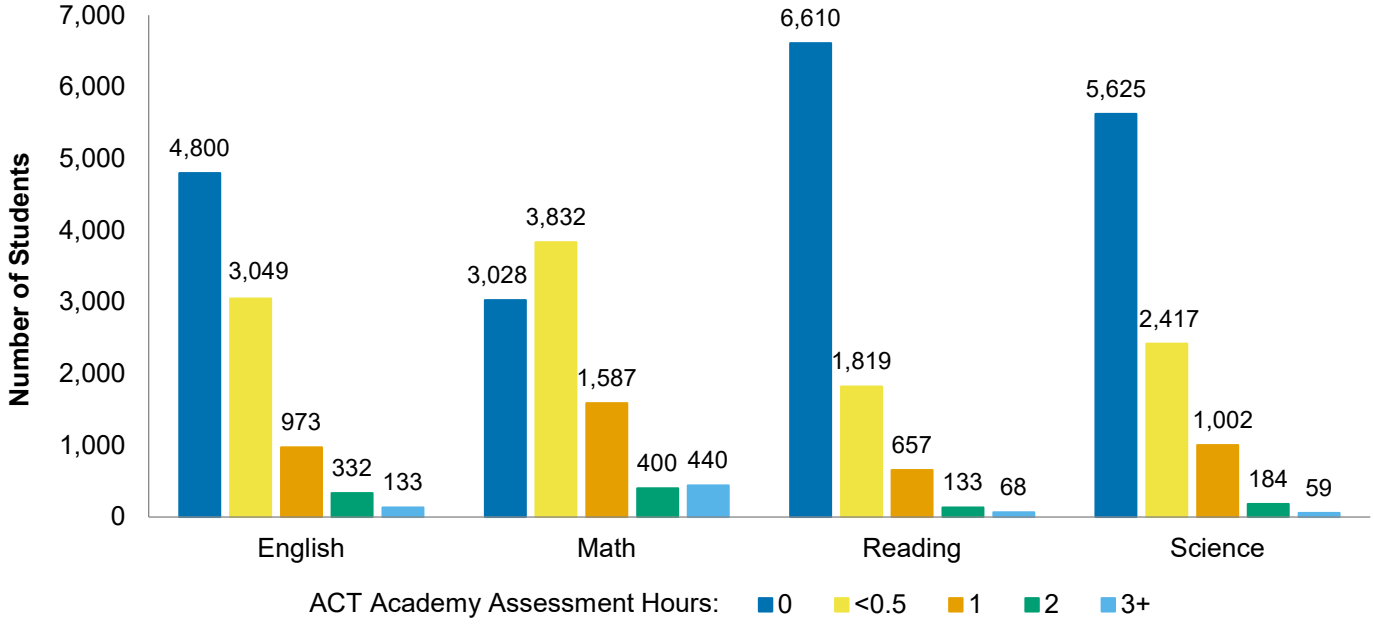
1. Calculate the median (P50) assessment time.
2. Among assessments completed within the median assessment time, calculate the truncated standard deviation (TSD) of assessment time.
3. Using the truncated standard deviation, estimate what the standard deviation would be for the entire distribution, under the assumption that the left side of the distribution (below the median) is symmetric to the right side of the distribution, and that the total distribution is normal. The formula for this modified standard deviation is MSD = TSD*sqrt(π/(π-2)) (Greene, 2003).
4. Outliers are identified as assessment times that are greater than P50 + 2*MSD.

Conceptually, this procedure for identifying outliers is the same as flagging values that are more than two standard deviations above the simple mean. But because the simple mean and standard deviation are very sensitive to severe outliers in assessment time, we used the steps above to use statistics (P50 and MSD) that are not sensitive to severe outliers in assessment time.

After calculating assessment duration for each student and each subject area, we inspected the frequency distributions. We found that many of the Academy participants had only used assessments in one subject area. Among the 9,287 participants, 48% were assessed on English, 67% on math, 29% on reading, and 39% on science. We sought a categorization of assessment hours that would result in a reasonably large number of students in each category.

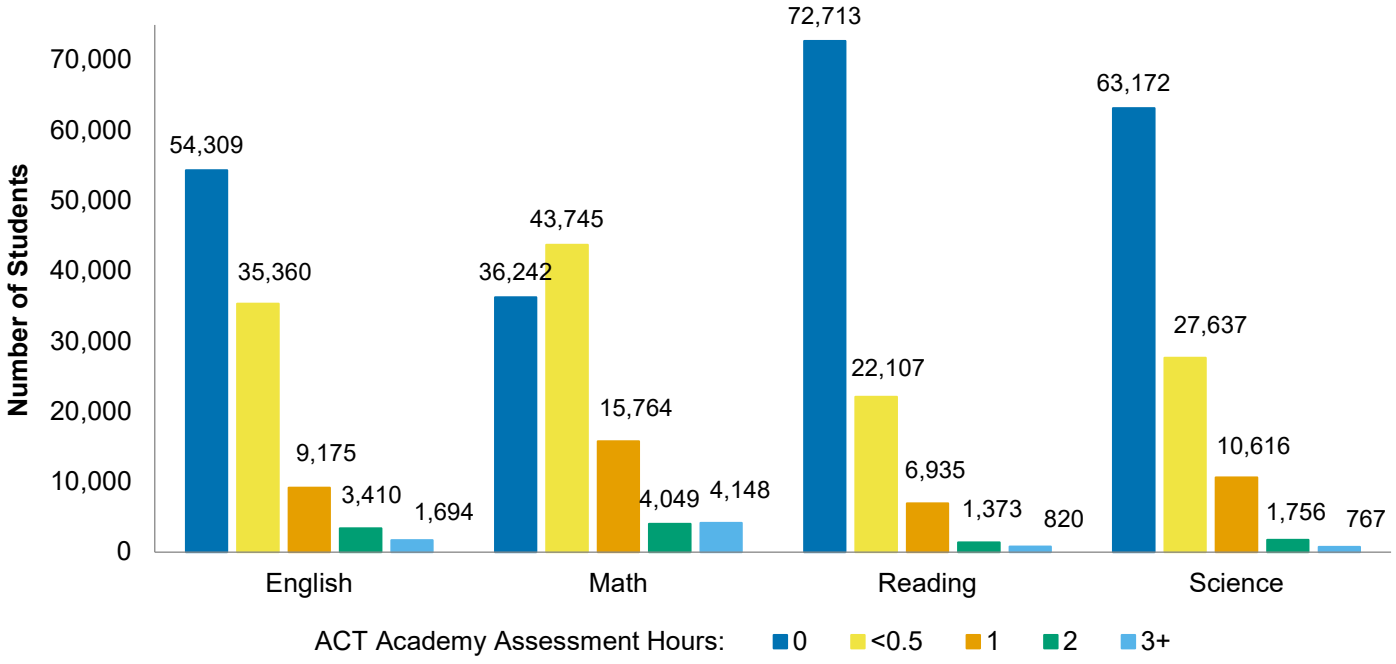
For each subject area, we categorized assessment duration into five levels: 0 (no assessment usage), <0.5 (some assessment use, but less than half an hour of assessments), 1 (0.5 to 1.5 hours of assessments), 2 (1.5 to 2.5 hours of assessments), and 3+ (more than 2.5 hours of assessments). Figure 5 provides the number of Academy participants in each assessment use level. The groups shown in Figure 5 can be thought of as treatment groups with different dosage levels. As dosage level increases, the number of students decreases. The number of students in the highest dosage groups are relatively small, especially for science (n=59) and reading (n=68).

Figure 5. Number of Students in RQ4 Sample, by Subject Area and ACT Academy Assessment Hours



Taking a step back to the sample used to examine RQ1 and RQ2 (n=103,948), we can examine the size of the participant groups for all students who have used ACT Academy assessments (Figure 6). We see that the levels of use among the population of ACT Academy users are similar to those of the restricted RQ4 sample. For the RQ4 sample, the percentage of students with at least one hour of assessment use was 15% for English, 26% for math, 9% for reading, and 13% for science. For the population of Academy users, the percentage of students with at least one hour of assessment use was 14% for English, 23% for math, 9% for reading, and 13% for science.

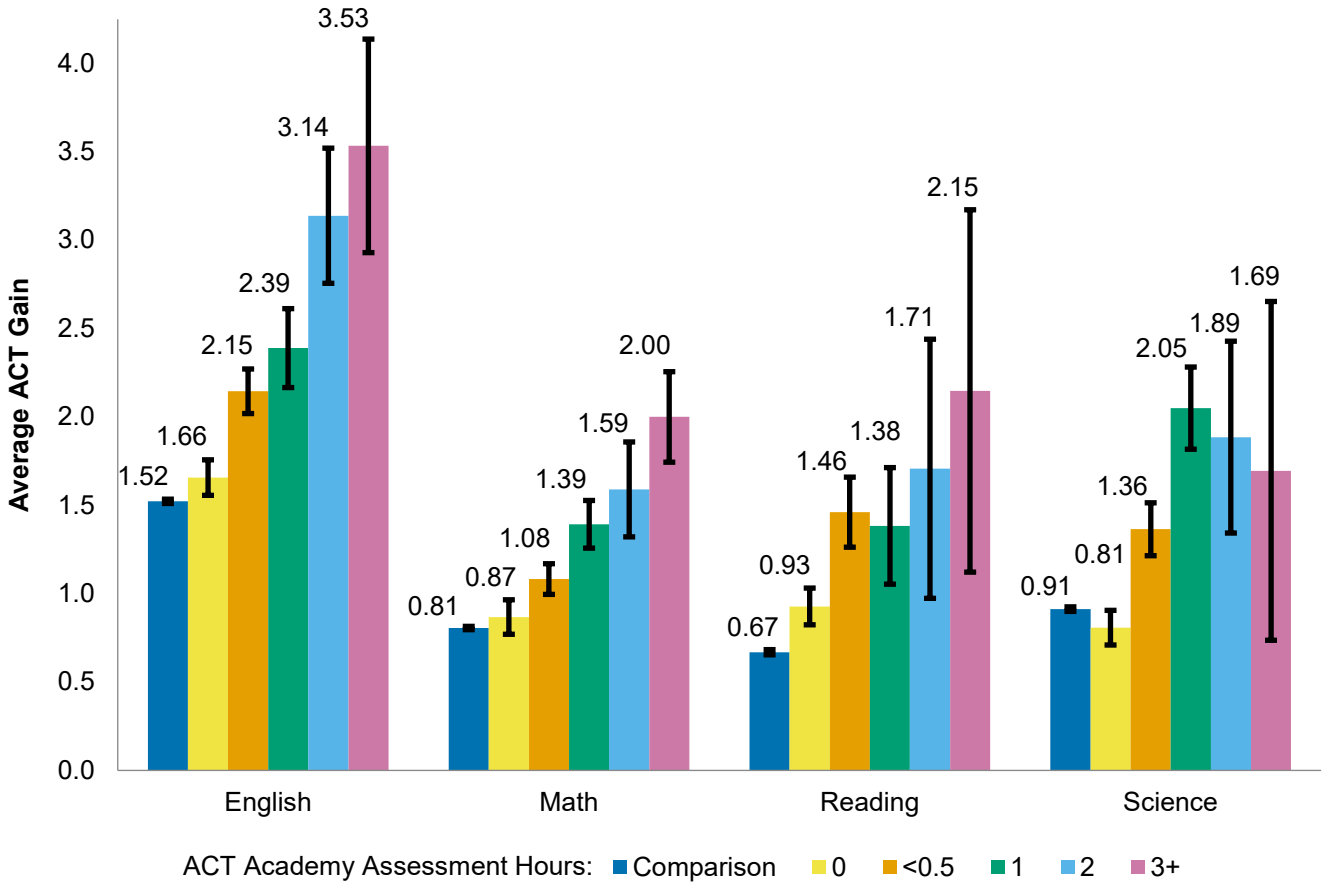
Figure 6. Number of ACT Academy Participants, by Subject Area and ACT Academy Assessment Hours



Next, we calculated the average ACT score gain (posttest score – pretest score) for each group of Academy participants, as well as for the comparison group. Figure 7 shows the average gain scores, and the black bars represent 95% confidence intervals for the average gain. Note that the confidence intervals are rather wide for the higher-dosage groups, especially for those in the 3+ hours group, because the sample sizes are relatively small.

From Figure 7, we see that average gain scores are largest in English (1.52 for the non-Academy comparison group) and smallest in reading (0.67 for the non-Academy comparison group). ACT scores generally increase with more ACT Academy assessment time. Exceptions are observed for reading, where the mean gain for the one-hour group is slightly lower than the mean for the <0.5-hour group, and for science, where the mean gain for the one-hour group is greater than the mean gains for the two-hour and 3+ hour groups. For each subject area, the average gain for the two-hour group is around twice that of the comparison group.

Figure 7. Average ACT Gain Scores, by Subject Area and ACT Academy Assessment Hours



The results shown in Figure 7 do not account for differences between the ACT Academy participants and the comparison group that could influence the choice to use ACT Academy, as well as ACT score gains (e.g., demographics, prior academic achievement, time between pre- and post-test). Table 3 compares the ACT Academy participant groups for English to the comparison group on several covariates.

Table 3. Student Characteristics of Comparison Group and ACT Academy English Participant Dosage Groups

Variable	Comparison Group	ACT Academy Assessment Hour Group: English				
		0	<0.5	1	2	3+
Gender, %						
Female	52.4	66.0	63.6	63.8	66.6	66.2
Male	47.6	34.0	36.4	36.2	33.4	33.8
Race/ethnicity, %						
African American	12.1	12.4	11.7	12.1	6.6	12.8
Asian	4.5	8.5	7.5	11.6	14.5	15.0
Hispanic	10.7	11.2	10.6	10.9	12.7	11.3
Other	6.1	6.3	6.0	5.4	5.7	8.3
White	63.6	58.9	61.5	57.5	56.0	50.4
Missing	2.9	2.7	2.7	2.5	4.5	2.3
Parent education level, %						
No college (1-2)	12.9	13.5	13.1	11.8	13.9	12.0
Some college (3-5)	17.0	18.3	20.1	19.2	18.4	16.5
Bachelors (6)	25.8	29.8	30.2	29.3	29.8	27.8
> Bachelors (7-8)	21.0	30.2	26.9	31.9	31.9	33.8
Missing	23.2	8.2	9.7	7.8	6.0	9.8
Average pretest Composite score	20.6	22.7	21.7	22.8	23.2	22.1
High school GPA, %						
<3.0	14.2	8.8	9.4	8.3	6.6	6.0
3.0-3.5	15.8	15.1	15.9	15.5	9.6	18.0
3.5-4.0	38.1	63.3	58.5	65.1	70.5	61.7
Missing	31.9	12.9	16.2	11.1	13.3	14.3
Average HSGPA	3.45	3.65	3.62	3.66	3.73	3.68
Average months between pretest/posttest	9.5	7.7	8.2	8.4	8.9	10.0
Pretest type, %						
ACT national	40.0	60.1	55.9	58.8	60.2	60.9
ACT state/district	14.5	16.7	16.6	14.7	11.7	9.0
PreACT	45.5	23.2	27.6	26.5	28.0	30.1
Posttest type, %						
ACT national	46.7	77.4	69.3	76.9	76.5	73.7
ACT state/district	53.3	22.6	30.7	23.1	23.5	26.3
Test accommodations, %						
No	92.6	97.4	96.2	97.3	98.2	95.5
Yes	7.4	2.6	3.8	2.7	1.8	4.5

From Table 3, we see that the ACT Academy participant groups are different than the comparison group on several variables. Academy participants are more likely to be female, Asian, have higher parent education level, have higher HSGPA, and to have tested on an ACT national test date for their pretest and posttest. Academy participants are less likely to be White, to have taken the PreACT as their pretest, and to have had a testing accommodation for their ACT posttest. There are also some differences across

the Academy participant dosage groups, but the differences are generally small. Table 3 only shows the comparison for English; the comparisons are similar for the other subject areas.

The comparison group and ACT Academy participant groups are different in ways that could confound comparisons of ACT score gains. We used a propensity score weighting technique (Austin, 2011) to achieve covariate balance between each participant group and the comparison group. Specifically, we took these steps:

- For each Academy participant group (i.e., each treatment dosage group) and each subject area, model the probability of being in the treatment group relative to the comparison group. Logistic regression was used to model treatment group status (students who used Academy) using the following predictor variables: gender, race/ethnicity (African American, White, Hispanic, Asian, Other, missing), parent education level (<high school, some college, bachelor's, more than bachelor's, missing), Composite pretest score, high school GPA (<3.0, 3.0-3.5, 3.5-4.0, missing), number of months between pretest and posttest, pretest type (PreACT, ACT national, ACT state/district), posttest type (ACT national or ACT state/district), and whether the student tested with special accommodations on the ACT posttest. The logistic regression model estimates the probability of being in the treatment group, which is used as the *propensity score* (*ps*).

- For students in the comparison group, assign a weight (*wt*) calculated as $wt = ps/(1-ps)$. For students in the Academy participant group, set $wt = 1$. By weighting the comparison group in this manner, we create a synthetic sample in which the distribution of covariates is independent of group (comparison vs. Academy participant group; Austin, 2011).

- The group difference in the weighted mean of the outcome (in our case, ACT gain score) represents the average treatment effect for the treated (ATT; Imbens, 2004). In our case, the ATT is the average effect of participating in ACT Academy assessments for students who participated (Austin, 2011).

These steps were performed separately for each participant dosage group (0, <0.5, 1, 2, 3+) and each subject area. After weighting, the comparison group is similar to each participant dosage group on the variables included in the propensity score model. For English, Table 4 shows the summary statistics for the weighted comparison group, as compared to each participant dosage group. Because members of the treatment group receive a weight of 1, the statistics in Table 4 for the treatment group are identical to the unweighted statistics (Table 3).

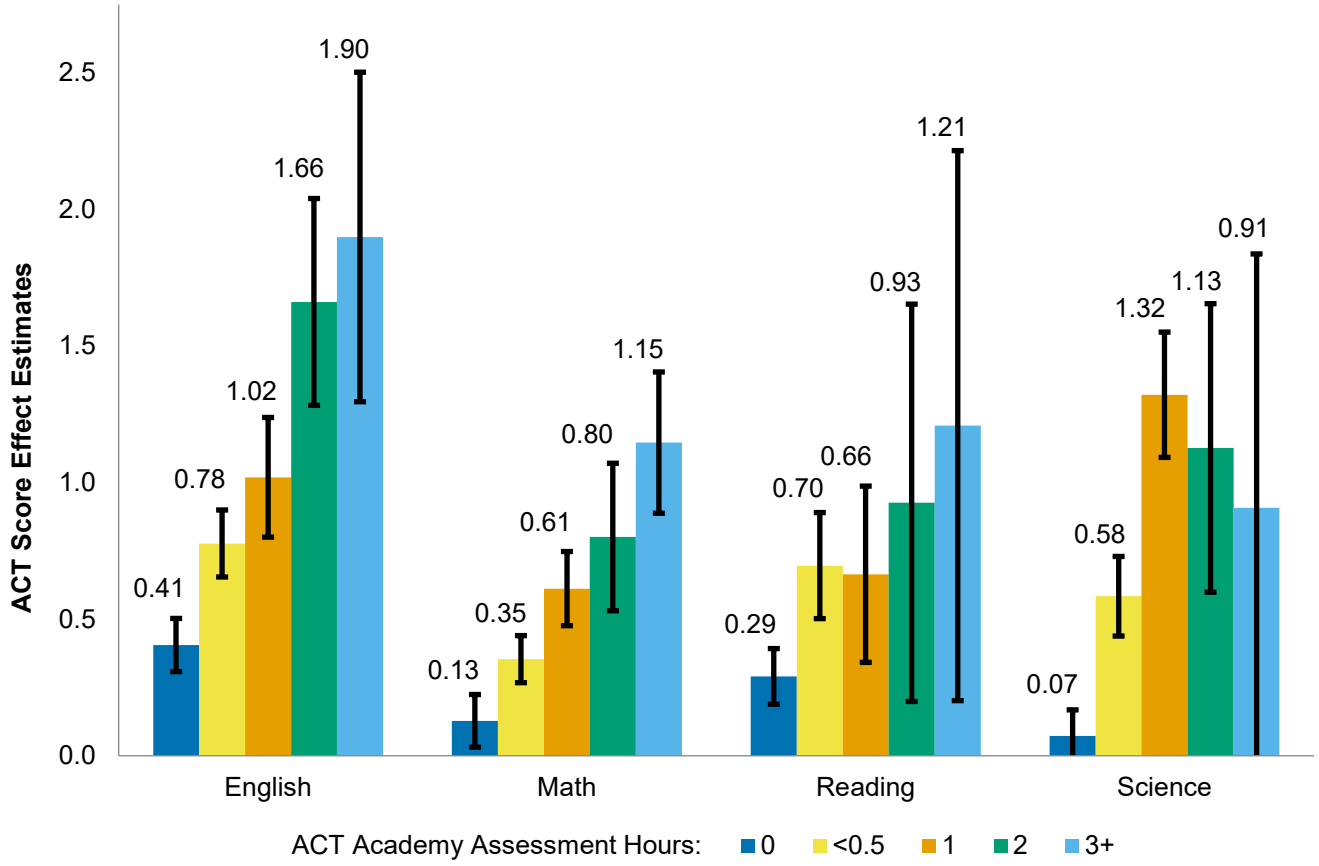
Table 4. Student Characteristics of Comparison Group and ACT Academy English Participant Dosage Groups, after Propensity Score Weighting

Variable	ACT Academy assessment hour group: English									
	0		<0.5		1		2		3+	
	T	C	T	C	T	C	T	C	T	C
Gender, %										
Female	66.0	66.0	63.6	63.6	63.8	63.8	66.6	66.5	66.2	66.0
Male	34.0	34.0	36.4	36.4	36.2	36.2	33.4	33.5	33.8	34.0
Race/ethnicity, %										
African American	12.4	12.4	11.7	10.8	12.1	12.1	6.6	6.9	12.8	11.4
Asian	8.5	8.5	7.5	7.5	11.6	11.6	14.5	14.3	15.0	14.6
Hispanic	11.2	10.8	10.6	10.8	10.9	10.9	12.7	12.7	11.3	12.3
Other	6.3	5.9	6.0	6.1	5.4	4.8	5.7	4.8	8.3	7.1
White	58.9	58.9	61.5	61.5	57.5	57.9	56.0	58.7	50.4	50.7
Missing	2.7	3.5	2.7	3.3	2.5	2.7	4.5	2.6	2.3	4.0
Parent education level, %										
No college (1-2)	13.5	13.6	13.1	12.3	11.8	12.1	13.9	11.7	12.0	13.3
Some college (3-5)	18.3	17.6	20.1	20.1	19.2	17.8	18.4	16.8	16.5	18.0
Bachelors (6)	29.8	30.2	30.2	29.2	29.3	30.7	29.8	30.6	27.8	29.2
> Bachelors (7-8)	30.2	28.2	26.9	25.6	31.9	29.0	31.9	29.7	33.8	26.8
Missing	8.2	10.4	9.7	12.8	7.8	10.5	6.0	11.2	9.8	12.7
Average pretest Composite score	22.7	22.7	21.7	21.9	22.8	22.8	23.2	23.2	22.1	21.9
High school GPA, %										
≤3.0	8.8	8.8	9.4	8.9	8.3	8.3	6.6	6.4	6.0	7.2
3.0-3.5	15.1	15.1	15.9	15.9	15.5	15.5	9.6	10.2	18.0	18.1
3.5-4.0	63.3	63.2	58.5	58.5	65.1	65.0	70.5	70.4	61.7	61.4
Missing	12.9	12.9	16.2	16.7	11.1	11.1	13.3	13.1	14.3	13.2
Average HSGPA	3.65	3.64	3.62	3.61	3.66	3.64	3.73	3.70	3.68	3.63
Average months between pretest/posttest	7.7	7.7	8.2	8.2	8.4	8.4	8.9	8.9	10.0	10.0
Pretest type, %										
ACT national	60.1	60.2	55.9	55.9	58.8	58.8	60.2	60.2	60.9	60.9
ACT state/district	16.7	16.7	16.6	16.6	14.7	14.7	11.7	11.8	9.0	9.1
PreACT	23.2	23.2	27.6	27.6	26.5	26.5	28.0	28.1	30.1	30.1
Posttest type, %										
ACT national	77.4	77.3	69.3	69.3	76.9	76.9	76.5	76.4	73.7	73.5
ACT state/district	22.6	22.7	30.7	30.7	23.1	23.1	23.5	23.6	26.3	26.5
Test accommodations, %										
No	97.4	97.3	96.2	96.2	97.3	97.3	98.2	98.1	95.5	94.5
Yes	2.6	2.7	3.8	3.8	2.7	2.7	1.8	1.9	4.5	5.5

Note: T = treatment group, C = comparison group.

While Figure 7 shows the unweighted mean ACT gain score for each group, Figure 8 (below) shows the difference in weighted mean ACT gain scores for each Academy participant group relative to the comparison group. The black bars represent 95% confidence intervals for the effect estimates. If the black bars encompass 0, the effect is not statistically significant.

Figure 8. Estimated Effects of ACT Academy Assessment Use on ACT Scores, by Subject Area



For example, consider the effects of participating in ACT Academy reading assessments for one hour (blue bar). From Figure 7, the unadjusted average ACT reading score gain is 1.38 for students who completed one hour of Academy Reading assessments and is 0.67 for the comparison group. Therefore, a raw estimate of the effect of participating in one hour of reading assessments is 0.71 (1.38-0.67) ACT score points. Figure 8 shows that the corresponding adjusted (weighted) mean gain score estimate is 0.66, with a 95% confidence interval of [0.34, 0.99]. In most cases, the raw effect estimates (derived from Figure 7) are similar to the adjusted effect estimates (Figure 8). Table 5 presents the raw and adjusted effects, along with standard errors and tests of statistical significance.

Table 5. Raw and Adjusted Effects of ACT Academy Participation

Subject	Group	N	Mean Gain		Raw Effect Estimate		Adjusted Effect Estimate		
			EST	SE	EST	SE	EST	SE	p-val
English	Comparison	326,599	1.52	0.01					
	0-hour	4,800	1.66	0.05	0.13	0.05	0.41	0.05	<.001
	<0.5-hour	3,049	2.15	0.06	0.62	0.06	0.78	0.06	<.001
	1-hour	973	2.39	0.11	0.87	0.11	1.02	0.11	<.001
	2-hour	332	3.14	0.19	1.62	0.19	1.66	0.19	<.001
	3+ hour	133	3.53	0.30	2.01	0.30	1.90	0.30	<.001
Math	Comparison	326,599	0.81	<0.01					
	0-hour	3,028	0.87	0.05	0.06	0.05	0.13	0.05	.008
	<0.5-hour	3,832	1.08	0.04	0.28	0.04	0.35	0.04	<.001
	1-hour	1,587	1.39	0.07	0.59	0.07	0.61	0.07	<.001
	2-hour	400	1.59	0.13	0.78	0.13	0.80	0.14	<.001
	3+ hour	440	2.00	0.13	1.19	0.13	1.15	0.13	<.001
Reading	Comparison	326,599	0.67	0.01					
	0-hour	6,610	0.93	0.05	0.26	0.05	0.29	0.05	<.001
	<0.5-hour	1,819	1.46	0.10	0.79	0.10	0.70	0.10	<.001
	1-hour	657	1.38	0.16	0.71	0.17	0.66	0.16	<.001
	2-hour	133	1.71	0.37	1.04	0.37	0.93	0.36	.011
	3+ hour	68	2.15	0.51	1.48	0.51	1.21	0.50	.016
Science	Comparison	326,599	0.91	0.01					
	0-hour	5,625	0.81	0.05	-0.11	0.05	0.07	0.05	.129
	<0.5-hour	2,417	1.36	0.07	0.45	0.08	0.58	0.07	<.001
	1-hour	1,002	2.05	0.12	1.14	0.12	1.32	0.11	<.001
	2-hour	184	1.89	0.27	0.97	0.27	1.13	0.26	<.001
	3+ hour	59	1.69	0.48	0.78	0.48	0.91	0.46	.051

Note: EST = estimate, SE = standard error

In all cases, the estimated effect of participation in ACT Academy assessments was positive, and in all cases but two (Science, 0-hour group and 3+ hour group) was statistically significant ($p < .05$). The effect estimates suggest that increased use of ACT Academy assessments results in larger ACT score gains. Students who spend an hour on ACT Academy assessments in one subject area can expect ACT subject score gains that are 0.6 to 1.3 points higher than if they had spent no time on ACT Academy assessments.

Students in the lowest dosage group (0-hour) participated in at least one assessment but none for the subject area in question. If the propensity score weighting method was effective (e.g., removed group differences in factors that may relate to ACT score gain), one might expect ACT score gains to be similar for the 0-hour and comparison groups because neither group had any known engagement with ACT Academy for the subject area in question. From Figure 7, we see that the 0-hour group had slightly higher ACT score gains in English, math, and reading. Possible explanations for this finding include:

- Students in the 0-hour group benefitted from non-assessment ACT Academy activities that were not tracked in this study (e.g., video resources, test-taking strategies).

- Students in the 0-hour group benefitted from participation in ACT Academy assessments from other subject areas. In other words, there could be spill-over effects where work in one subject area has a small positive effect on performance in other subject areas.

- The propensity score weighting procedure did not remove all baseline differences between participants and the comparison sample, and the participant groups show larger ACT score gains due, in part, to unmeasured factors (e.g., motivation to achieve a higher ACT score).

Effects on ACT Composite score

Up to this point of the analysis, we have focused on effects of ACT Academy assessment use on ACT subject test scores. However, students are most interested in increasing their ACT Composite score because it measures overall performance and is commonly used for college admissions and scholarships. Among the 9,287 students who participated in at least one assessment, the average Composite score gain was 1.33, compared to 0.98 for students in the comparison group. Thus, if we did not consider different levels of assessment dosage and differences in baseline covariates, we would conclude that use of Academy assessments leads to a 0.35-point increase in ACT Composite score.

We calculated total assessment time by summing the assessment durations across the four subject areas. After inspecting the frequency distribution of total assessment time, we grouped students into six dosage groups based on total assessment time: <0.5, 1 (0.5-1.5 hours), 2 (1.5-2.5 hours), 3-5 (2.5-5.5 hours), 6-10 (5.5-10.5 hours), and 10+ (>10.5 hours). We then used the same propensity score weighting methods described earlier to estimate the effects of different levels of assessment participation (Table 6).

Table 6. Effects of ACT Academy Participation on ACT Composite Score by Dosage Level

Total Assessment Hours	N	Mean Gain		Raw Effect Estimate		Adjusted Effect Estimate		
		EST	SE	EST	SE	EST	SE	p-val
Comparison	326,599	0.98	<0.01					
<0.5	4,861	1.17	0.03	0.19	0.03	0.33	0.03	<.001
1	2,470	1.36	0.05	0.38	0.05	0.49	0.04	<.001
2	843	1.50	0.08	0.52	0.08	0.59	0.07	<.001
3-5	779	1.61	0.08	0.63	0.08	0.70	0.08	<.001
6-10	265	2.32	0.14	1.34	0.14	1.29	0.14	<.001
>10	69	2.41	0.27	1.43	0.27	1.31	0.27	<.001

Note: EST = estimate, SE = standard error

Consistent with the subject-specific results, we find that ACT Composite scores increase with additional time spent on ACT Academy assessments. From Table 6, a student who spends 1.5-2.5 hours on assessments in each subject area (e.g., 6-10 hours total) could be expected to earn an ACT Composite score of about 1.29 points higher than if they had not spent any time on Academy assessments. This result is similar to what we would estimate from the subject-specific results: From Table 5, we would expect an effect of 1.13^{7} points on ACT Composite score following two hours (1.5-2.5 hours) of assessment in each subject. The estimated effect of spending 3-5 hours on assessments is 0.70 ACT Composite score points (Table 6), which is smaller than the estimate derived by averaging the subject-

specific effects related to one hour of use (0.90). One reason for this discrepancy is that students tend to accumulate more assessment hours in math, and the math effects are somewhat smaller than the effects for the other subject areas.

Discussion

Since its launch on March 22, 2018, ACT Academy has seen strong growth in the number of registered users and up to a 415% increase in user activity as measured by assessments completed between April and June for 2018 and 2019. As evidenced by the spikes in assessment usage before national ACT test administrations, students commonly use ACT Academy in close time proximity to the test ("cramming"). Usage also appears to be more concentrated on weekdays, suggesting that ACT Academy is implemented as a component of school-based test prep classes; in subsequent analyses, we plan to delve more deeply into this question. Consistent with our findings, a recent study (Moore, Sanchez, San Pedro, & Payne, 2019) found that schools in states with State and District testing are using advisory periods for test preparation at least one day per week for several months prior to the spring ACT test.

Taking quizzes is the dominant assessment activity in ACT Academy coupled with math as the dominant content area of focus; students complete almost as many assessments in math as the other three subjects combined. Relative to the ACT test-taking population, ACT Academy users are more likely to be high-achievers, female, Asian, attend non-public schools, and have parents with a higher education level. It was not surprising that states with more ACT-tested students tend to have more ACT Academy users, including some states with ACT State and District testing programs.

While relatively few students completed two or more hours of assessments in ACT Academy in each subject area, effects of assessment use on ACT gain scores are practically and statistically significant. After implementing propensity score weighting to achieve balance between ACT Academy participant dosage groups (0, <0.5, 1, 2, 3+ hours of assessments) and a comparison group, we see subject gain scores ranging from 0.61 to 1.32 points for students spending one hour completing assessments, 0.80 to 1.66 points for students spending two hours, and 0.91 to 1.90 points for students spending three or more hours. The prospect of increasing ACT scores by 1-2 points with what appears to be a reasonably short time commitment suggests a clear benefit to students.

Among all ACT Academy participants, the unadjusted average ACT Composite score gain was 1.33, compared to 0.98 for the comparison sample, suggesting a modest benefit of just 0.35 ACT Composite score points. We found that the effectiveness of ACT Academy depends heavily on how much time students spend on assessments. For example, students who spent approximately eight hours on Academy assessments saw, on average, an incremental gain in their ACT Composite score of 1.3 points. These results are aligned with previous research on the impact of preparation activities on score gains (Bangert-Drowns, Kulik, & Kulik, 1983; Montgomery & Lily, 2012; Powers, 1993; Appelrouth, et al., 2017; Moore, et al., 2018). Schiel and Valiga (2014a, 2014b) found a relationship between time invested in test preparation and ACT score gains. Students spending over 20 hours had an unadjusted average Composite score gain of 1.7, compared to 0.8 for students with no test prep. In a study of group and individual tutoring for the SAT, Appelrouth, Zabrucky, and Moore (2017) found that approximately 13 hours of tutoring increases SAT total score by 30 points (.25 SD), which is similar to a 1.4 point increase in ACT Composite score. A study of ACT Online Prep (Sanchez, 2019) found an incremental relationship between time spent using the tool and ACT Composite score gain with a difference of 0.44 points in ACT Composite score for those students using ACT Online Prep for 21+ hours (1.59 points) versus those who didn't use ACT Online Prep at all (1.16 points).

In comparison with some of these past studies, we found the same magnitude of an effect on the Composite score with only eight hours of time completing assessments. However, it is important to include the caveat that we were not able to include time spent reviewing the learning resources and other activities available to students in ACT Academy due to the limitations of the data set available. Time spent on assessments is only a proxy measure of overall engagement with ACT Academy, and additional research is needed to understand how time spent on assessments relates to total time spent in ACT Academy. It is possible the effects corresponding to the total time spent in ACT Academy may be comparable to the effect-time correspondence reported in previous studies.

There are two aspects to efficacy or effectiveness that are important to students and educators: One is improving ACT scores on subsequent tests, and the other is *efficiency* - the time required to achieve those score gains. Efficiency, at its core, is a return-on-investment argument. If ACT Academy can achieve the same score gains with less time and expense than other products or approaches, this is a significant advantage, particularly if we can demonstrate empirically that for a given increment of time spent actively engaged with the platform, students can expect a corresponding increase in their test scores.

Study Limitations

As mentioned previously, this study was limited to assessment completion data for both quizzes and practice tests and did not include any data that would provide a measure of time spent on learning resources (e.g., video lessons). Without these data, we cannot measure total time spent in Academy and can't make claims of superior efficiency of ACT Academy; however, the early indicators from this study look promising in this respect. Additional data will also help us measure engagement with ACT Academy in more nuanced ways, identify navigation strategies, and test if some strategies are more effective than others.

We attempted to eliminate the confounding effect of other forms of test preparation through the execution of exclusion criteria. We excluded students who indicated using other forms of test prep, as well as students known to have used ACT Online Prep and/or Online Prep Live. However, limitations of the data used to execute these exclusion criteria limit our ability to completely exclude students who used other forms of test prep. Further, it is possible that students who used other resources or had participated in school-based test-prep courses responded "No" to the questions regarding other forms of test prep. Most interviewees in a qualitative implementation study of ACT Online Prep (Moore, et al., 2019) indicated that in states where the ACT is required and used as an accountability measure, students may receive up to one hour per week of test preparation, both in terms of content instruction and test-taking strategies, for up to six months prior to taking the ACT during spring of their junior year. As a result, students from states with State and District testing may have answered "No" even though they received months of test prep instruction at school.

There are also limitations inherent in the observational, quasi-experimental design of this study. Without the ability to assign participants to specific treatment conditions, we cannot rule out the possibility that unobserved factors contribute to the differences we observed.

Future Research

Since this initial study only examines one aspect of Academy use (assessments), the scope of our inquiry was limited. Once a more comprehensive data set is available for research, we can begin studying the impact of ACT Academy on test preparation and learning by examining patterns of learner interaction with the platform as they relate to performance on assessments within Academy and score gains on the ACT. An important element to study is the use of learning resources and what viewing patterns might tell us about how students approach test prep. For instance, do students first view learning resources after incorrectly answering quiz questions or do they view suggested learning resources first before taking a quiz, as would be the case if they follow the daily plan? Do students watch videos to completion, or does it depend on the video's length? Do students scrub through a video, jumping around looking for specific content, or do they watch more sequentially from start to finish? Is there are relationship between assessment item response and assessment completion patterns and learning resource usage? Do the patterns of high-performing students look similar and are they distinct from lower-performing students?

The study used a pretest-posttest design and so only examined effects of ACT Academy usage for students who had already taken the ACT (or PreACT). It is possible that the effects of ACT Academy are different for first-time examinees who have not had prior exposure to the test and so may have more to gain in terms of familiarity with test format, test-taking strategies, and test content. Future studies should examine effects for first-time examinees. Similarly, future studies should examine whether the effects of using ACT Academy are similar for different subgroups of students, defined by characteristics such as baseline academic achievement level, race/ethnicity, gender, and socioeconomic status.

Combining research on learner response and usage patterns with more qualitative implementation studies of the school and home settings where students use Academy can provide valuable insight into how contextual affordances and constraints impact usage and outcomes. These insights could inform design decisions to improve the capabilities of the platform and what types of marketing outreach might be most beneficial. As Figure 3 suggests, the bulk of user activity is concentrated on weekdays. This would suggest that Academy is being integrated into school-based test preparation activities. It would be useful to better understand how schools are using Academy: as an independent, self-study tool or are teachers selecting specific assessments and learning resources and using the *Assignment* function to create a custom test prep curriculum for their students? What percentage of students who are introduced to Academy at school continue to use it at home?

The current study found a significant effect of ACT Academy usage on ACT test scores. The effect was largest for English, suggesting that the ACT English test is more amenable to practice and preparation or that ACT Academy's learning resources are relatively more effective for English. Additional research is needed to understand why the effect of using ACT Academy is stronger for English. Future studies could also examine if the benefits of using ACT Academy transfer to external outcomes, such as performance in high school and college courses, and skills, such as critical thinking, writing, and scientific reasoning. If it does lead to positive transfer of knowledge and skills, it would indicate broader effects on learning.

In conclusion, understanding ACT Academy as both a learning platform and test prep resource could help inform future development of the platform in terms of content, features, and functionality (i.e. more robust and differentiated corrective feedback, more scaffolding in activities, collaborative or peer instruction modes, game-based elements, etc.). Findings from this initial investigation of the effectiveness of ACT Academy show promising relationships between time spent on assessments and gain scores on the ACT; however, this is merely the beginning of an exploration of the potential of ACT Academy as a learning platform. As more data become available for research, increasingly compelling questions may be explored.

Notes

1. The reporting categories also correspond to the domains used to group the Common Core State Standards (www.corestandards.org) for reading, language, and math.
2. Some ACT state and district testing records cannot be used for this study due to contractual obligations and/or state data privacy laws.
3. Either PreACT or ACT test scores were used as pretest scores, and ACT test scores were used as posttest scores.
4. ACT Academy went live on March 22, 2018.
5. Based on highest of mother's and father's education levels.
6. Average based on highest of mother's and father's education levels, using the 1-8 ordinal scale.
7. 1.13 is derived as the average of the subject-specific effects (1.66 for English, 0.80 for math, 0.93 for reading, 1.13 for science) for the 2-hour groups.

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Appendix

Table A1. ACT Quizzes and Practice Tests Available in ACT Academy

Assessment name	Form	N Exams	N Students	Median Time
English practice test	1	7,983	7,201	57.4
	2	2,080	1,819	58.6
Math practice test	1	5,941	5,305	79.7
	2	2,383	1,994	90.9
Reading practice test	1	5,951	5,341	44.1
	2	1,637	1,415	40.0
Science practice test	1	7,198	6,527	42.4
	2	2,327	2,055	44.4
English: Conventions of standard English	I	5,855	4,551	5.7
	II	3,890	2,772	4.3
	III	2,796	2,133	4.3
	IV	2,550	1,814	5.7
	V	4,218	3,354	5.4
	VI	1,284	1,032	4.2
	VII	1,048	913	3.7
	VIII	955	822	3.4
	IX	881	793	3.5
	X	848	743	4.1
	XI	835	712	4.0
	XII	814	686	4.1
	XIII	837	704	4.1
	XIV	867	722	3.8
	XV	873	748	3.4
	XVI	954	792	2.5
	XVII	1,098	903	2.8
	XVIII	1,467	1,272	4.5
	XIX	16,756	13,127	4.8
English: Knowledge of language	I	9,368	7,186	7.3
	II	3,396	2,784	2.3
	III	2,879	2,428	2.5
	IV	2,530	2,074	1.4
	V	2,349	2,015	1.7
	VI	2,272	1,960	2.0
	VII	2,700	2,324	2.3
	VIII	29,760	18,612	2.2
English: Production of writing	I	15,745	12,455	10.0
	II	10,838	8,794	12.4
	III	5,565	4,291	4.3
	IV	4,787	3,732	3.2
	V	4,913	3,444	2.4
	VI	4,869	3,267	2.1
	VII	4,179	3,274	2.2
	VIII	5,433	3,984	2.9
	IX	37,802	24,998	2.8

Assessment name	Form	N Exams	N Students	Median Time
Math: Algebra	I	11,963	9,665	9.3
	II	6,101	4,074	3.6
	III	4,458	2,960	3.3
	IV	3,646	2,511	2.4
	V	3,373	2,312	1.7
	VI	3,046	2,245	3.1
	VII	2,843	2,096	3.6
	VIII	2,724	2,024	3.5
	IX	3,262	2,442	3.9
	X	34,136	23,080	6.0
Math: Functions	I	7,415	6,150	6.2
	II	3,831	2,430	4.3
	III	2,754	1,862	2.3
	IV	2,524	1,765	2.5
	V	14,441	10,331	3.3
Math: Geometry	I	6,013	5,080	11.2
	II	4,720	3,595	11.0
	III	2,129	1,562	4.8
	IV	1,774	1,325	3.8
	V	1,688	1,262	3.7
	VI	1,614	1,191	3.9
	VII	1,578	1,112	3.5
	VIII	1,839	1,381	3.8
	IX	18,125	13,275	6.4
Math: Integrating essential skills	I	3,920	3,307	7.4
	II	3,816	2,799	6.2
	III	1,846	1,377	4.8
	IV	1,717	1,255	4.3
	V	6,684	4,901	7.7
Math: Modeling	I	6,009	4,364	5.1
	II	2,319	1,726	4.3
	III	8,310	5,938	3.2
Math: Numbers and quantity	I	26,922	20,364	12.6
	II	13,141	9,289	3.1
	III	9,870	7,503	4.8
	IV	7,882	5,958	6.6
	V	3,345	2,499	5.5
	VI	6,326	4,617	4.1
	VII	7,218	5,313	5.8
	VIII	58,484	38,000	5.1
Math: Statistics and probability	I	7,308	5,469	8.4
	II	3,433	2,536	4.4
	III	15,087	11,331	4.9

Assessment name	Form	N Exams	N Students	Median Time
Reading: Craft and structure	I	3,403	2,440	4.6
	II	4,454	3,773	8.3
	III	1,230	913	3.6
	IV	985	680	5.0
	V	964	660	2.1
	VI	925	717	3.3
	VII	868	646	2.4
	VIII	892	623	2.7
	IX	1,348	1,035	3.3
	X	14,556	9,247	3.1
Reading: Integration of knowledge and ideas	I	3,476	2,652	7.1
	II	1,412	942	2.7
	III	1,195	769	2.3
	IV	939	681	2.4
	V	909	690	2.8
	VI	912	630	2.5
	VII	1,031	746	3.5
	IX	10,832	6,976	3.1
Reading: Key ideas and details	I	8,979	6,837	10.6
	II	4,651	3,539	5.5
	III	4,231	2,968	6.3
	IV	4,754	3,624	7.7
	V	2,188	1,669	3.2
	VI	1,872	1,408	4.9
	VII	1,636	1,221	5.1
	VIII	1,632	1,131	3.2
	IX	1,527	1,036	3.9
	X	1,748	1,083	2.7
	XI	1,457	1,072	3.7
	XII	1,674	1,145	3.1
	XIII	2,114	1,369	3.3
	XIV	2,488	1,857	3.3
	XV	21,250	14,630	4.6
Science: Evaluation of models, inferences, and experimental results	I	6,353	4,643	6.9
	II	11,427	8,395	8.5
Science: Interpretation of data	I	13,987	11,480	7.2
	II	10,330	7,969	5.5
	III	38,130	27,045	6.7
Science: Scientific Investigation	I	8,489	6,248	5.6
	II	19,283	13,724	7.3

Table A2. ACT-Tested ACT Academy Users, by State

State	ACT-tested Academy Users	ACT-tested graduates of 2018	Users per 100 graduates
Alabama	1,228	58,177	2.11
Alaska	48	2,582	1.86
Arizona	685	45,468	1.51
Arkansas	679	34,468	1.97
California	1,749	118,521	1.48
Colorado	238	17,081	1.39
Connecticut	167	10,534	1.59
Delaware	29	1,654	1.75
District of Columbia	23	1,748	1.32
Florida	2,270	119,543	1.90
Georgia	1,215	56,481	2.15
Hawaii	129	12,460	1.04
Idaho	140	7,352	1.90
Illinois	858	62,626	1.37
Indiana	345	23,580	1.46
Iowa	544	24,028	2.26
Kansas	520	25,103	2.07
Kentucky	951	51,814	1.84
Louisiana	1,258	55,711	2.26
Maine	16	1,043	1.53
Maryland	342	19,408	1.76
Massachusetts	329	18,219	1.81
Michigan	417	22,738	1.83
Minnesota	696	61,253	1.14
Mississippi	916	37,654	2.43
Missouri	951	68,424	1.39
Montana	188	9,731	1.93
Nebraska	329	24,516	1.34
Nevada	540	35,865	1.51
New Hampshire	38	2,440	1.56
New Jersey	466	32,590	1.43
New Mexico	223	13,749	1.62
New York	870	56,340	1.54
North Carolina	632	109,256	0.58
North Dakota	105	7,282	1.44
Ohio	1,507	127,392	1.18
Oklahoma	1,372	42,388	3.24
Oregon	184	15,432	1.19
Pennsylvania	563	27,694	2.03
Rhode Island	26	1,554	1.67
South Carolina	411	53,743	0.76
South Dakota	186	6,730	2.76
Tennessee	1,569	79,170	1.98
Texas	2,371	141,253	1.68
Utah	312	43,791	0.71
Vermont	41	1,633	2.51
Virginia	575	21,645	2.66
Washington	330	17,010	1.94
West Virginia	170	11,601	1.47
Wisconsin	716	68,000	1.05
Wyoming	188	6,342	2.96

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