Freckle Increases Math Scores in Elementary Students
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Abstract

KnowProgress conducted a study to determine Freckle’s effect on student test outcomes. In particular, KnowProgress analyzed if students using the adaptive math program in Freckle would show increased math test scores compared with students who did not use the software. Test scores from the Northwest Evaluation Association’s (NWEA) Measure of Academic Progress (MAP) in mathematics for 3rd, 4th and 5th grade were used for students at Isanti Intermediate School in Minnesota. The study is consistent with the hypothesis that Freckle’s math program results in higher MAP mathematics test scores.
Overview of Freckle

Freckle Education is a math and reading comprehension program designed to meet the needs of every learner in K-8 classrooms. With cross-curricular math and reading lessons, adaptive math and reading comprehension programs, assessments, and more, Freckle offers teachers a complete suite of Math and ELA resources.

This study focuses specifically on the usage of the adaptive math program offered by Freckle. When starting on the program, students take a diagnostic to determine what areas they excel in and what areas they would benefit from practicing further. As they continue to practice, Freckle adapts to each student’s learning patterns. This ensures that they are always facing material that is both challenging and engaging. Freckle is meant to be used multiple times a week in the classroom, and teachers have access to detailed data reports for each of their students. An example of a report is shown below:

Figure 1: Detailed student data view

Freckle’s mission is to provide teachers with tools that will help them meet the needs of every student in the classroom.
Executive Summary

Freckle is hypothesized to improve students’ mathematics outcomes. This study analyzes test scores of 3rd, 4th and 5th grade students, dividing them into experimental and control groups to understand the difference that Freckle makes on test scores.

This study examined two measures of the impact of using Freckle on test scores: (1) by comparing score growth for students of teachers who began using Freckle in different semesters, Fall and Winter and (2) by comparing score growth for students of teachers who used Freckle and those who didn’t.

The study gathered data from 386 3rd, 4th and 5th grade students at Isanti Intermediate School in the 2014-2015 academic school year, some of whom used Freckle and some of whom did not, and 440 3rd, 4th, and 5th grade students in the 2013-2014 school year, none of whom used Freckle. Some student data was excluded from the study due to incompleteness. The demographic characteristics of students in both the group that used Freckle and those that didn’t were not statistically different across measures of ethnicity, gender, special education students, and level of English proficiency.

This study evaluated whether test results were consistent with the prediction that using Freckle increases test scores in mathematics. To determine this, students’ scores on the Measure of Academic Progress (MAP) mathematics assessment were compared between Fall and Spring test scores. Experimental groups were subdivided into a Fall (F) and Winter (W) group depending on the semester when the teacher began using the Freckle software. The most important result of the study shows that students who started using the software in the Winter semester showed a 5.80 point (19.43-point growth vs. 13.63-point growth) greater mean score increase than students who did not use the software on the MAP math test. This difference was statistically significant (p <.001).

Some study limitations, including the lack of randomization of students using the Freckle software within teacher groups, were addressed through a Hierarchical Linear Modelling approach described below. Using this approach, we attempted to control for other classroom effects beyond the use of the Freckle software.

The results of this study provide strong evidence that Freckle increases mathematics tests scores in students grades 3-5.
Introduction

This study addressed the question: Do students who used Freckle exhibit higher end of year mathematics scores than students who did not use Freckle?

To answer this question, KnowProgress, an independent educational technology consulting firm, analyzed data generated by 3rd, 4th and 5th graders at Isanti Intermediate School in Minnesota. Data comes from the Measure of Academic Progress (MAP) assessment. The MAP assessment is administered by the Northwest Evaluation Association (NWEA) and is an adaptive measure of students’ mathematics achievement. It was predicted that students of teachers who used Freckle would exhibit higher end of year scores on the MAP assessment relative to students of teachers who did not use Freckle.

Method

This study allowed teachers to decide for themselves whether they wanted to use the Freckle software in their classrooms. It was not a randomized control study insofar as the students who used the Freckle software were not randomized within each teacher’s classroom. Instead, the scores of students whose teachers used the Freckle software were compared with the scores of students whose teachers did not. The teachers that used Freckle are referred to as the Freckle group and the teachers that did not are referred to as the Control group. There were 17 teachers (10 teachers in the Freckle group and 7 teachers in the Control group) and 386 students (222 students in the Freckle group and 164 students in the Control group) in this study.

Students in both groups took the MAP Math assessment at the beginning and end of the 2014 - 2015 academic year (i.e., the early Fall and late Spring, respectively). For the purposes of the study, students were split into three groups depending on when teachers began to use the Freckle software. Some began to use the software in Fall (F), some in Winter (W) and some did not use the software (A). The study compared the progress of students of all three groups with one another to see which group generated the highest score improvements from Fall to Spring on the MAP mathematics test.

Thirty-nine students did not have complete data and were excluded from the analysis. The complete analytic sample therefore consisted of 347 students. The difference in attrition between Freckle group and control group was not significant.

Student achievement data from the MAP assessment were analyzed by the independent educational organization KnowProgress. The scores were analyzed using Hierarchical Linear Models (HLM). HLM is used to control for other classroom effects that may be due to differences in teacher behavior beyond the decision to use the Freckle software.

Results
Both the Fall group (F) and the Winter group (W) showed statistically significant differences in mean score increase as compared with the control group (A) (P<.01). The control group (A) showed a mean score increase of 13.63 points. The Winter group (W) saw greater mean score increase (mean 19.43 points) than the Fall group (F) (16.55 points). Differences in mean score increase between the Fall group (F) and Winter group (W) were not statistically significant (P>.01). The total possible score on the MAP math test is 260.

The Hierarchical Linear Modeling (HLM) analysis technique was used in this study in order to account for the nested data structure in which students are grouped with teachers who either did or did not use the Freckle software in their classroom. Because students were not randomized within classrooms to control for classroom effects on learning other than software effects, we used the HLM technique to compare models that separate the students only by teacher to models that separate students by both teacher and whether or not that teacher used the Freckle software in their classroom.

Figure 2: Boxplots of mean score difference by starting semester. Groups are divided into those starting to use Freckle in the Fall (F), Winter (W) or not using the software (A).
In each HLM model, the data showed with a high degree of significance that the best fit model included the semester that teachers began to use the Freckle software (Fall, Winter or Control) rather than the model that included the teacher alone. This shows that the increased test score results for the experimental groups (Fall and Winter) are more likely due to the use of Freckle software than due to other classroom effects.

This study tests whether the treatment is statistically significant, accounting for individual aptitude and classroom effect. The null hypothesis contends that the effect of the treatment is not effective, whereas the alternative hypothesis holds that the treatment improves student test scores. We test that by performing a Likelihood Ratio Test (or an approximation of this) on the alternative model, which contains the treatment term, versus the null model, which does not contain the treatment term. If the alternative model is a significant improvement over the null model, then we conclude that the treatment term has a statistically significant difference and reject the null hypothesis.

The analysis run can be represented by the equation:

\[ y_{ijk} = \beta_0 + v_{0k} + u_{0jk} + X_{ijk} + e_{0ijk} \]

where

- \( y_{ijk} \) = student \( i \)'s end score
- \( \beta_0 \) = overall effect
- \( v_{0k} \) = effect of treatment \( k \) (classrooms which did or did not receive treatment)
- \( u_{0jk} \) = effect of classroom \( j \), nested within treatment \( k \)
- \( X_{ijk} \) = student \( i \)'s start score, nested within classroom \( j \) and treatment \( k \)
- \( e_{0ijk} \) = error of student \( i \), nested within classroom \( j \) and treatment \( k \)

Results show that the alternative model that controls for classroom effects is a statistically significant improvement over the null model \((p < .005)\). Thus, the data support the hypothesis that using Freckle shows a statistically significant improvement of test scores even when controlling for classroom effects other than the use of the software.

**Teacher interviews**

To get a deeper understanding of how teachers were using Freckle in their classrooms, Freckle interviewed teachers at Isanti about their experience with the program.

All teachers said they would highly recommend Freckle to others, saying that the program makes them more effective teachers. One teacher remarked that it made her more effective because “I can look at the reports on what they’re doing. Instead of wasting my time coming up with materials to differentiate, that’s already done for me. So I can spend my time being more effective working one-on-one or with a couple kids with the same issues. I don’t
have hours and hours of papers to
correct. Students get instant feedback
from [Freckle]”.

All teachers saw growth from using the
Freckle software, with one saying, “I've
seen huge growth. HUGE growth. Our
whole building saw tremendous growth
last year, and there are many different
reasons, but I would say one of the major
reasons was using Freckle, because it was
filling in those gaps instead of pushing
them ahead to the next standard”.

The adaptive nature of the Freckle
software allowed students of all levels to
be engaged, which teachers saw as
another of the program’s main benefits.
Teachers noticed that because of Freckle,
“the at-risk students will feel like they’re
on the same playing field as the high
achieving ones”, and gave examples of
high-performing students who had never
been challenged in math before being
engaged at their level through Freckle.

Overall, teachers found Freckle to be
very effective in their classroom for
students at all levels, increasing students’
confidence and enjoyment of math.
Discussion

Students in the Fall group (F) and Winter group (W) exhibited higher end of year achievement scores than students in the Control group (A). This effect held when controlling for classroom effects beyond the decision to either use or not use the Freckle software.

In 2015, the student norms for the MAP math test were a growth of 13 points for 3rd grade, 11.6 points for 4th grade, and 10 points for 5th grade. Thus, the growth of 19.43 points for the winter group represents a significant improvement for students throughout the course of one year.

Findings from this study support the hypothesis that using Freckle in the classroom improves student scores on the MAP math test.

Further Study

Because the study focused on data from one school, results may be smaller if conducted on a larger, more diverse population. In addition, since the students were not randomly selected to use Freckle, there may be other factors that influenced student performance on the MAP tests. Further study can try to utilize a randomized control trial across larger populations to draw more definitive conclusions.

Conclusions

These findings provide strong evidence that Freckle improves students’ mathematics test scores. Students in classrooms where teachers used Freckle exhibited much higher growth than students that did not. In addition, students who used Freckle grew significantly more than student norms for the NWEA MAP test. However, future studies can utilize random assignment to groups to more conclusively determine Freckle’s impact on student outcomes.
KnowProgress is an independent educational technology consulting firm based in the San Francisco Bay Area. KnowProgress specializes in efficacy studies, data analysis, and educational product development. For more information, please contact info@knowprogress.com.