# Analysis of the Level of Usage of STEMscopes and Students' 5th Grade STAAR™ Scores

## Description of the Study

The purpose of this study was to examine the level of usage among STEMscopes teachers in a medium-sized, suburban district to determine if varying levels of use of STEMscopes were associated with student proficiency in science, as measured by the Texas state science assessment.

STEMscopes is a comprehensive, online K-12 science curriculum that is 100% aligned to the Texas science standards (the Texas Essential Knowledge and Skills) and that combines online content, activities, and teacher materials with hands-on experiments and explorations. The online component of STEMscopes serves as both a support and a guide to teachers, as well as a platform through which students can interact with the material and get feedback on their progress.

STEMscopes uses an inquiry-based approach to science, in which the teacher guides students towards the discovery of concepts and skills instead of using explicit direct instruction (Crawford, 2007). The specific way that STEMscopes delivers inquiry-based instruction is by building on the Biological Science Curriculum Study's 5E inquiry model (Bybee et al., 2006). The 5E refers to five steps: engagement, exploration, explanation, elaboration, and evaluation. Engagement refers to how teachers activate students' prior knowledge about and interest in a new topic, building connections between what they know and what they are learning. Exploration is the step where students take part in activities and experiments that allow them to experience and learn new concepts and skills. Explanation requires students to explain those new concepts and skills learned during the explore phase. Elaboration challenges them to deepen their conceptual understanding through new, but related, experiences. Finally, in the evaluation phase, students' knowledge is assessed to inform teachers of their progress towards mastery.

The STEMscopes pedagogical model adds two key steps: intervention and acceleration to make it the 5E+I/A model. Intervention means that STEMscopes provides teachers with the tools both to identify where students are struggling and to provide them with additional opportunities to learn and practice those learning objectives. Acceleration refers to the activities that STEMscopes provides for those students that have demonstrated mastery of a particular learning objective. For example, students can undertake a problem-based learning challenge, or connect science to art through a creative project. These two tools help teachers differentiate their instruction and address students' individual learning needs (Zuiker & Whitaker, 2014).

### Design

Data for this study were collected in two ways. First, we acquired fifth grade student, teacher, and school data from the participating school district for the 2012-2013 school year. The district under study adopted the STEMscopes curriculum district-wide as their elementary science curriculum. Therefore, all elementary schools and fifth grade teachers and students were included in the analyses. Second, we utilized learning analytics from the STEMscopes website to measure how the teachers from the participating district interacted with the curriculum.

Learning analytics applies methods, theories, and statistical models to the analysis of educational datasets (Bienkowski, Feng, & Means, 2012). The STEMscopes analytics platform allows us to analyze data about page visits to STEMscopes content by districts, schools, and users, both teachers and students. In other words, we are able to see what online use of the curriculum looks like 'behind the scenes' by viewing and analyzing what pages and content viewers are 'clicking on' and in what order. In this report we define "visit" as a click to any page in STEMscopes that corresponds to a science topic (or TEKS covered) within the 5E+I/A framework embedded within the curriculum.

**Participants**

Data on school characteristics, student demographics, and student science scores on the state assessment called the STAAR™ exam were collected for all fifth grade students in the district for the 2012-2013 school year. Table 1 describes the 34 Elementary schools, 140 fifth grade teachers, and 3,470 fifth grade students in the district. Of the 34 schools, 10 elementary schools (29%) were Title 1 schools. On average, teachers had 12 years of teaching experience and were assigned 31 students. The fifth grade students in this district were predominantly White and Hispanic, and about a third of students were considered economically disadvantaged.

Table 1: School, Teachers, and Student Descriptive Statistics for District

| | |
|---|---|
| Elmentary Schools | $n$ = 34 |
| Title 1 | 29% |
| 5th Grade Teachers | $n$ = 140 |
| Average Teacher Experience | 12 years |
| Average Number of Students | 31 |
| 5th Grade Students | $n$ = 3,470 |
| Female | 51% |
| White | 45% |
| Hispanic | 30% |
| African American | 9% |
| Asian | 12% |
| Other | 5% |
| Economic Disadvantage | 32% |
| Limited Engish Proficiency (LEP) | 9% |
| Bilingual (BIL) | 4% |
| English as a Second Language (ESL) | 5% |
| Special Education | 9% |
| Gifted/Talented | 11% |
| 2012-2013 STAAR Science Average Scale Score | 3968.7 |

**Analyses**

Multilevel analyses were conducted to determine if different levels of teacher usage of STEMscopes (based on the learning analytics data) were associated with students' science achievement. The user analytics data served as a measure of dosage or intensity of implementation. Teachers that accessed the STEMscopes website and teacher dashboard at any

point during the school year were included in these analyses. Levels of usage were measured in three ways based on the user analytics data:

- Total number of visits to any learning standard
- Total number of visits to any of the 5E+I/A steps within each learning standard
- Average number of steps visited for every learning standard

Descriptive statistics from the learning analytics variables are provided in Table 2. Using multilevel regression analysis, the three learning analytics variables were aggregated and entered as teacher-level predictors of students' science achievement, controlling for school-, teacher-, and student-level covariates. Separate models were analyzed for each user analytics variable.

Table 2. Descriptive Statistics for User Analytics Variables

| | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|
| Totl Number Visits to Standards | 477.5 | 547.0 | 1.0 | 3377.0 |
| Total Number Visits to 5E+I/A Steps | 6.5 | 1.6 | 1.0 | 8.0 |
| Average Steps Visited per Standard | 2.7 | 1.1 | 1.0 | 5.0 |

## Results of the Study

Results from these models can be found in Table 3 below. The total number of visits to any learning objective content or to any of the 5E+ I/A steps was not significantly associated with students' science achievement. The average number of steps visited per learning standard was significantly and positive associated with student science achievement, controlling for other differences. In practice, this meant that those teachers who completed more of a lesson had students with higher scores than teachers who implemented less of a lesson. In fact, teachers who used STEMscopes more often, as defined by utilizing more of the 5E+ I/A steps per learning standard, had students whose average scale scores were 46.6 points higher than teachers who used fewer steps per learning standard (effect size: Cohen's $D = 0.20$). The effect size for this result is comparable with benchmark effect sizes calculated for similar interventions in $4^{th}$-$5^{th}$ grades (Hill, Bloom, Black, & Lipsey, 2008).

In addition to teacher use of STEMscopes, the schools' Title 1 status was negatively associated with student science achievement. For the student-level variables, male students and students considered gifted and talented had higher scores science scores. Students who were Hispanic or African American scored lower than White students. Finally, Students with an economic disadvantage, a special education classification, or who were considered limited English Proficiency had lower science scores.

Table 3. Results from HLM Models Examining STEMscopes™ Usage Levels

| | STAAR Science Scores | | |
|---|---|---|---|
| | *B* | *SE* | *p*-value |
| *School-Level Predictors* | | | |
| Title 1 | -125.8** | 36.86 | 0.002 |
| *Teacher-Level Predictors* | | | |
| **Use of STEMscopes** | **46.6**** | **16.38** | **0.008** |
| Years Teaching Experience | -0.6 | 2.07 | 0.788 |
| Number of Students | -0.5 | 0.78 | 0.551 |
| *Student-Level Predictors* | | | |
| Female | -82.5*** | 14.68 | < .001 |
| Hispanic | -123.3*** | 19.64 | < .001 |
| African American | -246.1*** | 28.94 | < .001 |
| Asian | -2.8 | 25.83 | 0.914 |
| Other | -57.0 | 35.42 | 0.108 |
| Economic Disadvantage | -205.4*** | 19.92 | < .001 |
| Limited Engish Proficiency (LEP) | -278.4*** | 77.77 | < .001 |
| Bilingual (BIL) | 61.8 | 68.40 | 0.367 |
| English as a Second Language (ESL) | 62.1 | 83.68 | 0.458 |
| Special Education | -476.2*** | 26.60 | < .001 |
| Gifted/Talented | 510.8*** | 24.67 | < .001 |

*Note.* Science scores represent student scale scores (Range = 1,000-6,000). For ethnicity, White is the reference group.
*** $p < .001$, ** $p < .01$, * $p < .05$

## Conclusions

The research team found that students in STEMscopes classrooms whose teachers utilized more of the 5E+I/A steps to teach a learning standard taught had higher science achievement scores by an average of 46.6 scale score points than teachers who utilized fewer steps per learning standard, even after controlling for important school- and student-level differences. Practically speaking, this finding suggests that those teachers who implement the curriculum with more fidelity by utilizing more of its steps had better results than those teachers who implemented with less fidelity. These findings provide evidence for the efficacy of the curriculum and for the 5E+I/A instructional model.

## References


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