Registry of Efficacy and Effectiveness Studies

**Study Title:**
An Efficacy Study of the MathSpring Personalized Learning System That Responds to Student Affect

**Registry ID:** #1885.1v1

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**Version History**

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**Section I: General Study Information**

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**Study start date:** 2019-07-01  
**Study end date:** 2023-06-30

**Intervention start date:** 2020-08-01

**Timing of entry:** Prior to implementation of the intervention

**Brief abstract:**
Mathematics education continues to be an important focus for national education improvement efforts and more districts are introducing technology as a part of their solution. We propose to conduct an initial study to generate evidence of the efficacy of MathSpring, an online personalized learning platform that detects students’ emotions and responds with affective support when students are engaged with mathematics problem solving. MathSpring has been fully developed and promising results from pilot studies provides a
basis for a larger-scale, independent, more rigorous evaluation of the efficacy of the intervention. The study sample will include 80 6th grade mathematics teachers from approximately 40 public schools in the state of Massachusetts, with approximately 4,000 students. The study is aligned with Massachusetts’ focus on using personalized learning to improve student mathematics learning and leverage the availability and support for technology in the state. We will seek to recruit a representative sample of schools in Massachusetts and ensure the sample includes low-performing schools and schools with lower-socioeconomic status student bodies. Teachers and students in Grade 6 will use MathSpring as a supplemental program to support their problem-solving practice. Teachers will make assignments online and receive diagnostic reports to facilitate their review of students’ progress and adapt their instruction accordingly. Students will work on solving problems that are customized to their individual needs and receive (a) immediate feedback on their answers to problems; (b) multimedia worked-out examples and hint messages to help solve difficult problems; (c) affective support through animated pedagogical agents; (d) messages to promote growth mindset; and (e) a student progress page for them to reflect on their own progress and set goals. Teachers will receive professional development to support their use of the reports as a formative assessment tool to target classroom practices. Teachers assigned to the business-as-usual control condition will continue using existing instructional practices and supplemental technologies (other than MathSpring). The study will use a clustered randomized experimental design to answer a set of research questions about the primary outcome, moderators, mediators, and implementation fidelity. Teachers will be blocked by school and randomly assigned to either the treatment or control condition and will be asked to participate for 2 full school years (2020–21 and 2021–22). Data on implementation fidelity and contrast between conditions will be collected in both years. Grade 6 Massachusetts Comprehensive Assessment System (MCAS) assessment and Mathematics Diagnostic Testing Project (MDTP) Grade 7 Readiness Test will be the primary measures of student mathematics achievement.

Keywords: Personalized learning, affect, math, technology

Comments:

Section II: Description of Study

Type of intervention:
Curriculum/Product

Topic area of intervention:
Education Technology, Mathematics and Science Education

Number of intervention arms:
1

Target school level of intervention:
6

Target school type:
Rural, Urban, Suburban

Location of implementation:
United States: Northeast

Further description of location:
Massachusetts

Brief description of intervention arm:
Teachers and students in Grade 6 will use MathSpring as a supplemental program to support their problem-
solving practice. Teachers will make assignments online and receive diagnostic reports to facilitate their review of students’ progress and adapt their instruction accordingly. Students will work on solving problems that are customized to their individual needs and receive (a) immediate feedback on their answers to problems; (b) multimedia worked-out examples and hint messages to help solve difficult problems; (c) affective support through animated pedagogical agents; (d) messages to promote growth mindset; and (e) a student progress page for them to reflect on their own progress and set goals. Teachers will receive professional development to support their use of the reports as a formative assessment tool to target classroom practices.

**Brief description of comparison condition:**
Teachers assigned to the business-as-usual control condition will continue using existing instructional practices and supplemental technologies (other than MathSpring).

**Comparison condition:** Business-as-usual

**Comments:**

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**Section III: Research Questions**

**Confirmatory research questions:**

*Question 1*
In the classes that adopt MathSpring as a supplement for grade 6 mathematics, compared with classes that continue with existing programs (the business-as-usual), do students have higher mathematics achievement scores on the MCAS exam or the supplemental outcome measure at the end of grade 6?

*Question 2*
Do the effects of MathSpring vary for students with different levels of prior achievement?

*Question 3*
Do the effects of MathSpring vary for students with different demographic characteristics (e.g., gender, socio-economic status, race/ethnicity, rural status)?

**Exploratory research questions:**

*Question 1*
How does MathSpring affect students’ approaches to learning and disposition towards mathematics?

*Question 2*
Does MathSpring lead teachers to provide more targeted instructional activities?

*Question 3*
How does MathSpring lead to changes in affects over time?

*Question 4*
What is the fidelity of implementation and the effects of implementation on learning?

**Comments:**

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Section IV-A starts on the next page.
Section IV-A: Study Design (Selection)

**Study Design:**
Randomized Trial (RT)

**Comments:**

Section IV-B: Study Design (Input)

**Unit of random assignment of intervention:**
Teacher

**Assignment within blocks or selected strata:**
Yes

**Define the natural blocks or purposefully selected strata:**
School

**Probability of assignment to treatment the same across blocks or strata:**
Yes

**Probability of assignment to treatment:**
0.5

**Unit outcome data measured:**
Student

**Intermediate clusters between unit of random assignment and unit of measurement:**
No

**Design Classification:**
RT: Multisite (Blocked) Cluster Randomized Trial

*Comments*

Section V: Sample Characteristics

**Approximate number of students per teacher:** 50

**Approximate number of teachers in the comparison condition within each school:** 1

**Approximate number of teachers in the intervention condition within each school:** 1

**Number of schools:** 40

**Certain students that were targeted for the study:**
No

**Certain students that were excluded from the study:**
Yes - Self-contained special education classes
Certain teachers that were targeted for the study: No

Certain teachers that were excluded from the study: No

Certain schools that were targeted for the study: No

Certain schools that were excluded from the study: Yes - Schools that couldn't provide technology access to 6th grade students.

Comments

Section VI-A: Outcomes (Selection)

Confirmatory question 1 - number of outcome measures: 2

Confirmatory question 2 - number of outcome measures: 2

Confirmatory question 3 - number of outcome measures: 2

Comments:

Confirmatory Question 1, Outcome Measure 1

Outcome domain: Student Achievement - Mathematics

Minimum detectable effect size: 0.2

Outcome measure: Mathematics scaled scores from the Massachusetts Comprehensive Assessment System (MCAS)/MCAS test

Scale of outcome measure: Continuous

Normed or state test: Yes

Same outcome measure in treatment and comparison groups: Yes

Confirmatory Question 1, Outcome Measure 2

Outcome domain: Student Achievement - Mathematics

Minimum detectable effect size: 0.2

Outcome measure: Grade 7 Mathematics Readiness Test
**Scale of outcome measure:** Continuous

**Normed or state test:** Yes

**Same outcome measure in treatment and comparison groups:** Yes

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**Confirmatory Question 2, Outcome Measure 1**

**Outcome domain:** Student Achievement - Mathematics

**Minimum detectable effect size:** 0.15

**Outcome measure:** Mathematics scaled scores from the Massachusetts Comprehensive Assessment System (MCAS) MCAS test

**Scale of outcome measure:** Continuous

**Normed or state test:** Yes

**Same outcome measure in treatment and comparison groups:** Yes

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**Confirmatory Question 2, Outcome Measure 2**

**Outcome domain:** Student Achievement - Mathematics

**Minimum detectable effect size:** 0.15

**Outcome measure:** Grade 7 Mathematics Readiness Test

**Scale of outcome measure:** Continuous

**Normed or state test:** Yes

**Same outcome measure in treatment and comparison groups:** Yes

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**Confirmatory Question 3, Outcome Measure 1**

**Outcome domain:** Student Achievement - Mathematics

**Minimum detectable effect size:** 0.15

**Outcome measure:** Mathematics scaled scores from the Massachusetts Comprehensive Assessment System (MCAS) MCAS test

**Scale of outcome measure:** Continuous

**Normed or state test:** Yes

**Same outcome measure in treatment and comparison groups:** Yes
Confirmatory Question 3, Outcome Measure 2

Outcome domain: Student Achievement - Mathematics

Minimum detectable effect size: 0.15

Outcome measure: Grade 7 Mathematics Readiness Test

Scale of outcome measure: Continuous

Normed or state test: Yes

Same outcome measure in treatment and comparison groups: Yes

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Comments:

Section VII: Analysis Plan

Baseline data collected prior to start of intervention: Yes

Description of baseline data:
MCAS Grade 6 math test scores

Covariates to include at the student level in the model:
Gender, Free/reduced lunch status, Race, Student Pretest

Covariates to include at the teacher level in the model:
Aggregate of Individual Characteristics, Aggregate of Baseline Scores

Analytic model:

Plan to handle cases with missing outcome data:
Delete cases with missing data for the outcome being analyzed

Planned multiple comparisons adjustment, confirmatory question 1 (Student Achievement - Mathematics):
Yes

Number of planned comparisons to adjust, confirmatory question 1 (Student Achievement - Mathematics):
Two

Correction for multiple comparisons, confirmatory question 1 (Student Achievement - Mathematics):
Benjamini-Hochberg correction

Planned multiple comparisons adjustment, confirmatory question 2 (Student Achievement - Mathematics):
Yes
Number of planned comparisons to adjust, confirmatory question 2 (Student Achievement - Mathematics):
Two

Correction for multiple comparisons, confirmatory question 2 (Student Achievement - Mathematics):
Benjamini-Hochberg correction

Planned multiple comparisons adjustment, confirmatory question 3 (Student Achievement - Mathematics):
Yes

Number of planned comparisons to adjust, confirmatory question 3 (Student Achievement - Mathematics):
6

Correction for multiple comparisons, confirmatory question 3 (Student Achievement - Mathematics):
Benjamini-Hochberg correction

Comments:

Section VIII: Additional Materials
Right click to open files in a new window.

Links

No links have been added yet.

Files

File Name: Data Analysis Plan.docx
Description: Analysis plan for primary outcome, moderator and mediation analysis.

Comments