2020 Education Innovation and Research (EIR) Project Directors and Evaluators Technical Assistance Meeting

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Evaluation of the Learning by Making Program

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LbyM-p Pilot Study

The LbyM-p Pilot occurred during 2014-2018, and was funded by the i3 program. "Leaming by Making: STEM Success for Mendocino County" U411C130090 - 13A

i3 Research Questions

- RQ1: Does *LbyM-p* have an effect on mathematics performance of 9th to 12th grade students compared to mathematics performance of 9th to 12th grade students in the business-as-usual condition?
- RQ2: Does *LbyM-p* have an effect on science performance of 9th to 12th grade students compared to science performance of 9th to 12th grade students in the business-as-usual condition?
- RQ3: Does *LbyM-p* increase high school students' interests in STEM and a STEM career?

i3 Study Design

- Quasi-experimental design study
- 7 treatment classes and 7 comparison classrooms from 6 schools
- 278 high school students in two treatment groups
  - 137 students in treatment group
  - 141 students in comparison group

i3 Data Collection

- Student math and science performance
  - Student math and science assessments
  - Classroom observations, teacher interviews and focus groups
- Teacher instructional practices and technological competencies
  - Teacher survey
  - Teacher interviews and focus groups
- Student attitudes toward STEM and STEM careers
  - Student survey
  - Classroom observations, teacher interviews and focus groups

Math and Science Performance

Post-intervention outcomes for the analytic sample and estimated effects in a two group, two level study, 9-12th GRADE ONLY (N=150)

Outcome Measure	Covariate-Adjusted Mean		Covariate-Adjusted Mean Difference	*p*-Value	95% Confidence Interval	Effect Size
	Intervention (N = 98)	Comparison (N = 52)				
Math	50.73 (2.12)	46.21 (3.02)	4.52 (3.89)	0.25	-3.10 – 12.14	0.17
Science	49.36 (1.68)	41.49 (2.39)	7.87 (3.07)	0.01	1.85 – 13.88	0.34

Student STEM Attitudes Survey

Mean survey response scores by scale (1-5) (N = 108)

	Intervention students				Comparison students			
Scale	**Pre-survey mean**	**Post-survey mean**	**Mean diff**	**N**	**Pre-survey mean**	**Post-survey mean**	**Mean diff**	**N**
Math	3.35 (0.78)	3.25 (0.87)	-0.10 (0.50)$^{+}$	75	3.48 (0.96)	3.41 (1.00)	-0.08 (0.51)	33
Science	3.14 (0.57)	2.99 (0.70)	-0.15 (0.58)*	75	3.57 (0.71)	3.55 (0.75)	-0.02 (0.52)	31
Engineering	3.47 (0.67)	3.27 (0.85)	-0.20 (0.67)**	74	3.34 (0.66)	3.23 (0.76)	-0.12 (0.53)	33
21st Century	3.90 (0.52)	3.85 (0.63)	-0.05 (0.59)	73	4.16 (0.57)	4.09 (0.55)	-0.07 (0.47)	33

Student STEM Attitudes

"When you make it fun, it's easier to learn too, because you can actually understand it in other ways. Last year, all I did when I was in science was bookwork. Constantly bookwork, and I never was able to really understand what they meant, even with the teacher trying to explain."

- LbyM 9th grade student

Teacher Practices and Competency

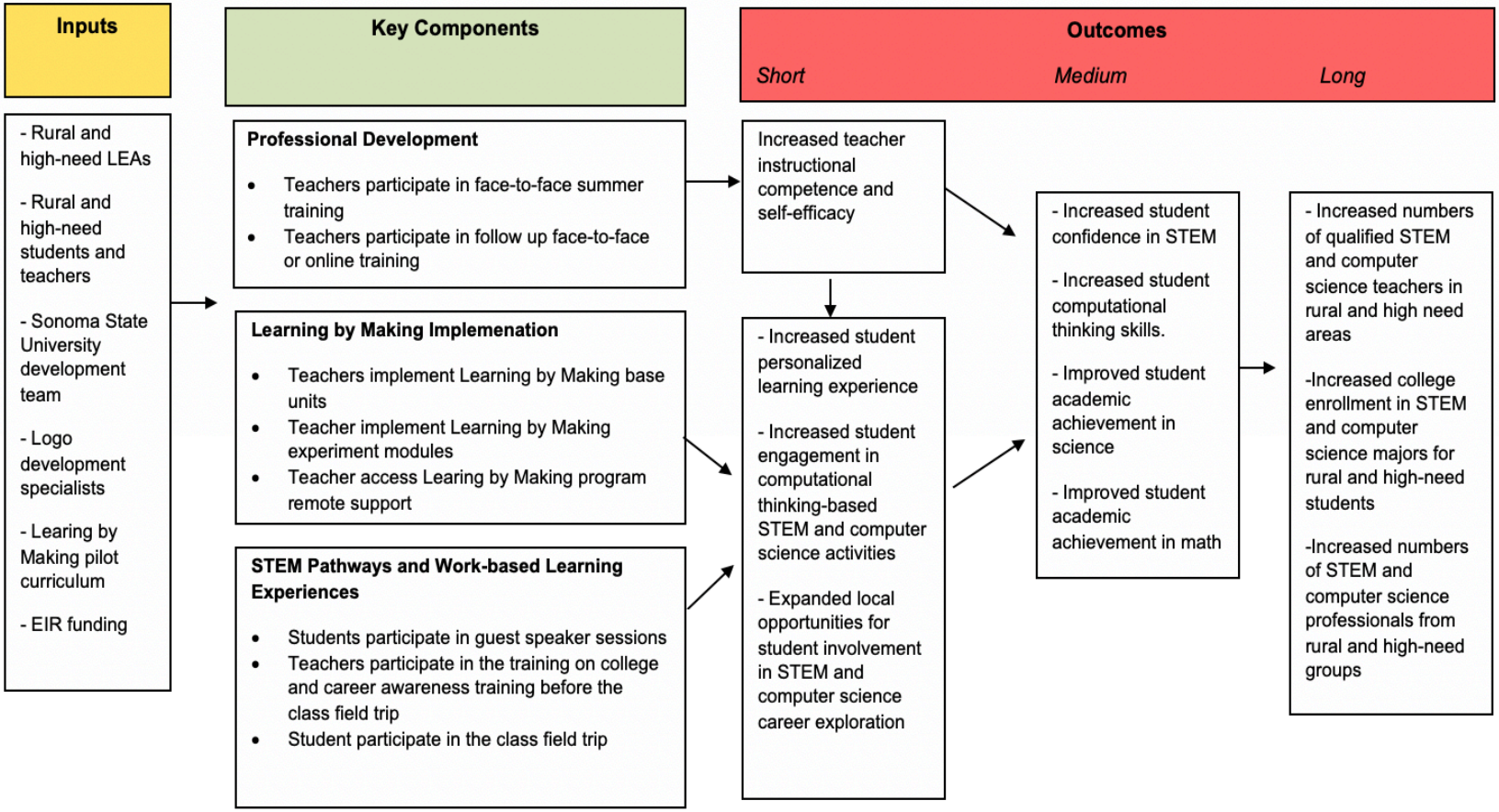
- Increased instructional time on:
  - Collecting data by counting, measuring or observing
  - Displaying and analyzing data
  - Using technology to solve problems
  - Organizing, outlining, or summarizing information
- NGSS-aligned teaching practices:
  - Project-based learning
  - Student-centered, inquiry-driven learning

"The idea of giving [students] a little bit of information about a thing, letting them practice it, seeing how to build the skill, and then let them come up with their means of going through a project."

LbyM Initial Efficacy Study in 2021-2022

The ongoing LbyM program (2018-2023) is funded by the EIR program: “Developing a Student-Driven STEM and Computer Science Curriculum for Rural Students” U411C180146

Logic Model



External Factors

- Rural regions have few STEM and computer science-oriented opportunities for work-based learning and future employment
- Isolation of rural teachers and schools can be bridged using technology
- Rapid changes in technology necessitate updates of implementation platform

EIR Research Questions

- RQ1. What is the effect of the LbyM program on the mathematics achievement of 9th grade students compared to the business-as-usual condition?
- RQ2. What is the effect of the LbyM program on the science achievement of 9th grade students compared to the business-as-usual condition?
- RQ3: What is the effect of the LbyM program on 9th grade students' interests in STEM and a STEM career?
- RQ4: Were the key components of the *LbyM* program implemented as planned?
- RQ5: How much variation in implementation fidelity is there across classrooms, and what factors contribute to the ability of teachers to implement the *LbyM* program with high fidelity?
- RQ6: What were the barriers to and facilitators of implementation?

Impact Study Design

- A multisite or blocked trial design
- 9th grade students within each participating school will be randomly assigned into a LbyM classroom or a business-as-usual science classroom
- ~500 students from 3-5 schools

Sample Identifications

- Schools:
  - More than two 9th grade teachers
  - Agree to randomly assign eligible students
- Teachers:
  - Eligible to teach 9th grade life science or environmental science
  - Agree to teach LbyM and participate in summer and follow up trainings
- Students
  - 9th grade students
  - Take life science or environmental science
  - Don’t opt-out from the randomized controlled study

LbyM Innovations

The LbyM curriculum contains an array of (5) innovations that set it apart from other, non-NGSS-aligned science curricula”

1. Helping students to make sense of phenomena and design solutions to problems
2. Supporting three-dimensional learning
3. Incorporating computational thinking into science classrooms.
4. Deepening teacher expertise and agency in STEM
5. Fostering STEM career pathways

EIR Implementation Data Collection

- PD observations
- General classroom implementation observations
- Teacher interviews
- Student focus groups

EIR Outcome Data Collection

- Student math and science performance as measured by NWEA
- Student attitudes towards science, mathematics, engineering and technology, 21st century skills, and STEM career
- Student scientific sensemaking related to generating testable questions, designing investigations or experiments, interpretation of data and/or tables, constructing mechanistic explanations, and nature of science

EIR Outcome Data Collection - Continued

- Student engagement observations
  - **Behavioral engagement:** On-task, Off-task
  - **Affective engagement:** Concentrated, Bored, Confused, Frustrated

Other qualities we do not know how to assess

- Resilience
- Grit
- Coding skills
- Circuit building skills
- Measurement skills
- Troubleshooting ability – for both computer code and electronic circuits
- Task performance

How would you assess resilience and grit?

How would you assess troubleshooting ability?