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Massachusetts *Linking Experiences & Pathways (M-LEAP)* Research Project

Executive Summary

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M-LEAP
Massachusetts
Linking Experiences and Pathways

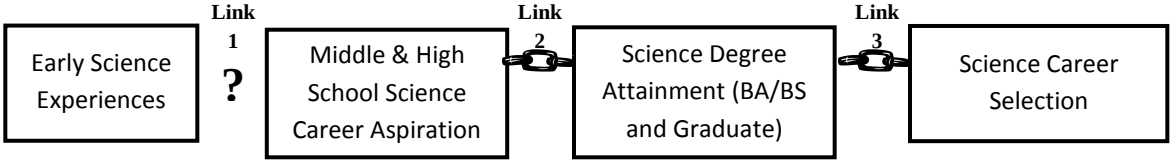
The **Massachusetts Linking Experiences and Pathways (M-LEAP)** project was a three-year longitudinal study designed by Goodman Research Group, Inc. (GRG) to investigate what contributes to elementary and middle school students deciding to pursue or retreat from STEM areas and career aspirations. Funded by the National Science Foundation's Division of Gender in Science and Engineering (NSF GSE), we focused primarily on gender differences in these causes, with an eye toward better understanding how girls' and boys' science-related beliefs, experiences, and aspirations (SBEAs) develop and differ at a young age. If we can identify variables in childhood that affect 8th grade science career aspirations, then perhaps we can better understand the factors underlying the gender gap in science career attainment in adulthood. The ultimate aim of our study was to advance knowledge about attracting girls and young women into science careers.

M-LEAP is the first longitudinal study to statistically assess early science experiences in elementary school.

The project's name reflects the longitudinal nature of our study and the fact that we are interested in how early experiences are linked to later experiences that lead down various academic and career paths. For practical purposes, we conducted the study solely within Massachusetts, focusing on students, their parents, and teachers in eight schools — one school in each of eight districts across the state.

WHY M-LEAP?

A great deal of research conducted over the last three decades has established a series of factors that can be linked to STEM achievement. That research contributed greatly to what we have termed "Links in the Science Pathway" (see exhibit), which is a representation of the path toward attaining a science career. Research has shown that there is a connection between wanting a science career in middle and high school and pursuing and receiving a science degree in college. It has also shown that there is a link between receiving a degree in science and choosing a science career. These links represent the insights contained within the existing body of evidence that allows us to explain gender differences in the STEM workforce by connecting them with earlier life experiences.



We decided to focus on understanding Link 1, which connects early science experiences with career aspirations during middle and high school. We have framed our research to study how early in- and out-of-school science-related beliefs, experiences, and aspirations (SBEAs) in grades 3-8 were related to gender-based differences in science achievement-related choices. Thus, the M-LEAP study asks two related overarching questions:

1. What factors contribute to the development of science career choice at a young age?
2. Are experiences prior to 8th grade related to later life outcomes associated with science career attainment?

Building on Eccles' Expectancy-Value (E-V) Model

As a guiding framework for measuring the impact of science-related beliefs, experiences, and aspirations, our research used the Eccles Expectancy-Value (E-V) Model of Achievement-Related Choices. This model seeks to explain individuals' achievement-related choices (e.g., what courses to enroll in and what career to choose) as a factor of their ratings on psychological constructs such as self-efficacy (SE), i.e., an individual's perception of how good he or she is at something, and subjective task value (STV), i.e., the perceived value of investing time and energy into one activity versus another. In other words, the E-V model theorizes that individuals are motivated to make these decisions – in this case, decisions about STEM subjects – based on how positive and valuable they expect the outcomes to be.

We hypothesized that boys have significantly more science experiences outside of school (e.g., in out of school activities, clubs, and excursions) than do girls and that boys in 8th grade have more science-related beliefs, experiences, and aspirations than do girls. We also hypothesized that students who have a richer and more positive set of experiences in and beliefs about science at a young age will have a higher perception of how good they are at STEM subjects and how useful those STEM subjects are to their futures. Thus, they will be more likely to hold science career aspirations as they get older.

THREE MAJOR RESEARCH QUESTIONS

- **What science-related beliefs, experiences, and aspirations do children have between 3rd and 8th grade? How do they differ by gender?**
- **How are science-related beliefs, experiences, and aspirations related to each other, and are there gender-based differences?**
- **How do science-related beliefs, experiences, and aspirations change over time? How are these early science-related beliefs, experiences, and aspirations associated with 8th grade achievement-related choices? How do these relationships differ by gender?**

METHODS IN BRIEF

More than 1,300 elementary and middle school students participated over the three years of the study.

Our sample of students was diverse in terms of race and ethnicity, socioeconomic demographics, geographic location, and average MCAS scores. We collected data from a variety of sources at eight K-8 schools in Massachusetts, using several instruments, some of which were translated into Spanish, Portuguese, and Haitian Creole. We used **student, parent, and teacher surveys, student and science specialist interviews, and community data scans** to compile rich qualitative and quantitative data.

KEY FINDINGS

Both boys and girls thought they were good at reading/ELA, math, science, computers, and teamwork, but boys gave themselves higher self-assessments in the STEM fields than did girls. Boys thought the STEM fields and teamwork are useful subjects for their futures, while girls thought reading/ELA is useful. Both boys and girls thought that STEM fields are more useful than interesting. Teachers saw girls as lacking interest in science,

WHAT COUNTS AS A STEM ACTIVITY?

- **Reading or watching shows about science, math, and computers**
- **Engaging in hands-on activities involving STEM subjects**
- **Visiting science and technology museums**

though they thought boys and girls are equally capable in the STEM fields.

Girls who rated themselves more highly in science over time said it was because the topics got more interesting. Boys did the same thing, but the influence of their teacher was also important.

Frequently participating in STEM activities outside of school was linked to being more likely to perceive STEM subjects as being highly useful for students' futures. The students did not participate in very many STEM-related activities outside of school. Boys participated more often than did girls, but participation rates for both genders declined as they got older. Frequent participation in extracurricular STEM activities was consistently positively related to their attitudes about these subjects and the type of job that they aspired to. Unfortunately, most students in our sample reported participating in such activities infrequently (less than once a month).

WAYS TO INCREASE PARTICIPATION IN OUT-OF-SCHOOL ACTIVITIES

- **Encouraging parents to involve their children in STEM-related out-of-school activities, even if a child does not seem to "gravitate toward" these areas.**

Encouraging students to engage in more out-of-school STEM activities may increase a student's perception of how useful a subject is — and perhaps thereby how good a student thinks he or she is at that subject — in a self-reinforcing way.

WAYS PARENTS CAN COMMUNICATE ABOUT THE VALUE OF STEM

- **Providing students with positive reinforcement about STEM subjects and skills.**
- **Participating in "family science learning" with their children.**

Children were very good at figuring out how much value their parents placed on particular subject areas. When parents thought it was important for their child to well in a certain area, their children thought that area was both more useful and more interesting. However, students believed that parents placed more importance on math and reading/ELA than on science, whereas parents tended to place equal importance across the board. We found that parental attitudes towards STEM — whether about the value of doing well in STEM subjects, their children's abilities in those subjects, or their own level of comfort with these subjects — were important determinants of these student outcomes. Thus, parents can do a clearer job of conveying to their children their valuing of STEM subjects and skills.

When children were told they were good at a subject, they thought that subject was more useful and had an increased perception of how good they were at that subject – regardless of subject or the person giving the feedback. Children were most commonly told that they were a "math person," while very few students reported being told that they were a "science person." When a student identified as a "math person," our study found that he or she tended to aspire to a traditional STEM career, but the same was not true of students who were told they were a "science person" or a "computer person."

WAYS TO PREVENT BOY-FAVORING STEREOTYPES

- **Informing parents about the risks of holding gender stereotypes and encouraging them to be gender neutral in how good they think boys and girls are at STEM subjects and skills.**

SOME WAYS TO ENHANCE MATH SELF-ABILITY RATINGS AND SCIENCE UTILITY RATINGS

- **Educators promoting engagement and interest in STEM subjects by infusing enthusiasm, using hands-on teaching methods, and focusing on process skill as much as content.**
- **Educating students about STEM jobs and how to pursue a career in the STEM fields.**
- **Colleges and universities partnering with local elementary and middle schools to engage in outreach efforts to teach students about working and studying in STEM areas.**
- **A properly trained support network of professionals working in STEM fields visiting schools to get students thinking about aspiring to a STEM job and mentoring students interested in pursuing these jobs.**
- **Making science relatable so that the public sees it as part of everyday life through the media.**
- **An evidence-based, multi-media, multi-platform campaign introducing young students to STEM jobs and boosting their attitudes towards STEM subjects.**
- **A truly coordinated effort to provide resources to students, parents, teachers, and professionals who wish to help students, particularly girls, become more interested in STEM.**

When parents believed that boys were better at STEM subjects than girls, girls sometimes did worse in STEM. Girls thought STEM subjects are less useful and less interesting, and believed that they were not as good at them as at non-STEM fields like reading/ELA. Parents who believed boys are better at STEM subjects had sons with *higher* science and math self-ability ratings and daughters with *lower* science and math self-ability scores. To the extent girls had lower self-ability ratings in math, they were correspondingly less likely to aspire to STEM jobs. Thus, working to change parents' beliefs in boy-favoring stereotypes about STEM may be beneficial to girls' own self-ratings in math and science.

A large percentage of both boys and girls hoped to receive a graduate degree. The older our students got, the higher the degree they hoped to achieve. Students who hoped to go into the STEM-fields believed they would get more formal schooling (i.e., get a higher degree) than did those who wanted to enter a non-STEM career.

Boys said they hoped to have a STEM career more often than did girls, but more girls than boys said they hoped to enter an allied health field. The majority of students, however, regardless of gender, preferred non-STEM careers. It is possible that intervening to increase students' valuing of or interest in a STEM subject could lead to increases in their self-ability ratings in that subject, and vice versa.

Visual media was the most common source for boys for learning about their preferred STEM job, followed by knowing someone, while for girls it was knowing someone and written media. Most students did not have a complete understanding of what it took to get their job of choice.

NEXT STEPS – OR LEAPS!

When we initially proposed M-LEAP, we posited that future extensions to our study could follow students through high school, using growth modeling to track attitudinal changes toward STEM training and job aspirations, and participation in related curricular and extracurricular activities. In fall 2013, NSF awarded GRG a three-year grant for M-LEAP 2. In this current follow-on study, we are following a small subset (N = 72) families from M-LEAP — students, their parents, and siblings — with the intent of more deeply understanding external and internal motivations for pursuing interests in STEM and/or non-STEM fields.

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