Pathways to STEM Outcomes:
Not Always Involving Early Motivation and Early Ability

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Objectives and Theoretical Framework

Researchers and policymakers often use the metaphor of an ever-narrowing pipeline to describe the trajectory to a STEM degree or career (Blickenstaff, 2005; National Academy of Science, 2005; Metcalf, 2010; Pawley & Hoegh, 2011). However, the pipeline metaphor is inadequate as a framework to guide inquiry into the role that early motivation and early ability play along the pathways to careers in STEM. The metaphor diminishes attention to important variation in which students might build critical competences or develop STEM career motivations at much later points; further the metaphor has led to misguided responses that have had little success at increasing the number and improving the quality of STEM professionals.

This study was undertaken in order to address the following research questions: (1) What proportion of scientists and engineers demonstrate early motivation in pursuing STEM and the ability to succeed in STEM?; (2) Are scientists and engineers who either do not have an early motivation toward STEM or do not complete rigorous high school math courses rare exceptions or are they a sizeable subset of the population?; and (3) How might the relationship between motivation and ability be more accurately emphasized in investigating trajectories towards both STEM degree attainment and career entrance?

Methods and Data Sources

Data were drawn from the National Educational Longitudinal Study of the Eighth-Grade Class of 1988 (NELS:88). The NELS:88 used a two-stage national probability sample of approximately 24,600 eighth graders enrolled in public and private schools in 1988. These students were followed over twelve years and were resurveyed in 1990, 1992, when many were high school seniors, 1994 and again in 2000, when many had entered the workforce. Our sample consisted of individuals who were a part of the eighth-grade cohort of 1988, had high school transcript data available, and had completed a 4-year college degree by the year 2000, when most were 26 or 27 years old. These restrictions along with excluding individuals with missing responses to career expectations or planned field of post-secondary education reduced the overall unweighted sample size to roughly 3320.

We identified three salient variables in the literature that are often used to indicate STEM related motivation and ability. The three identified variables include: eighth-grade science or engineering career expectation (Tai et al. 2006), earning credits in calculus while in high school (Adelman, 2006), and intention to study a STEM field after high school while in twelfth-grade (Maltese & Tai, 2011). Earning credits in calculus while in high school is a proxy of academic capacity, or ability, and both eighth-grade science or engineering career expectation, and planning to study a STEM field while in twelfth-
grade are used as measures of interest in, or motivation toward, STEM. We used these variables to define different pathways of pursuing science or engineering careers.

We then identified four pathway composites, each representing a potential pathway archetype to STEM degrees or careers. The first composite included the pathways with some element of career or study interest and high school calculus. The second composite included only those pathways that included HS calculus but did not express an interest in pursuing science or engineering as a career or field of post-secondary study. The third composite included pathways of individuals that at some point expressed a specific interest in pursuing science or engineering as a career or field of post-secondary study but did not take calculus while in high school. The last composite included pathways of individuals who did not take calculus nor expressed a specific interest in pursuing science or engineering as a career or field of post-secondary study. We then identified the proportion of those who earned STEM degrees and then entered STEM careers that followed each of the 4 composites.

Results and Significance

We found that while it is true that many scientists or engineers both took calculus and had an interest in pursuing STEM after high school (likely not independent indicators), a majority of scientists and engineers did not have both of these, and a sizeable plurality had neither. The two composites that include early interest comprise the majority (70%) of the pathways taken to the STEM workforce, emphasizing the importance of early interest in STEM. Comparatively, just over half of STEM professionals had taken Calculus in high school. Further, the STEM professions vary in the relative strength of the different pathways.

It is our view that further research utilizing, elaborating, and challenging these composites will lead to richer insights into how people engage in STEM academic pursuits and enter the STEM workforce. Such research will illuminate key temporal, dispositional, and contextual leverage points for policy makers and educators. Further, these pathway composites may also help tailor interventions in ways that are more likely to lead to each of a wide range of desired outcomes, such as broader scientific literacy, enhanced participation of underrepresented groups, and retaining top talent in STEM fields.

References


