NAPA VALLEY COLLEGE

Research, Planning and Institutional Effectiveness

STEM performance

May 2025

Background

Diverse student populations, including first-generation students, underrepresented minorities, and women, are vital for the STEM workforce, and community colleges serve as a significant entry point for many who begin their STEM studies there. Despite good career prospects, persistence in STEM fields at community colleges and subsequent transfer to universities is often low, particularly for underrepresented and under-resourced students. This low persistence and success is a persistent concern in community colleges. A major barrier identified is the traditional system of developmental or remedial education, particularly in mathematics, which serves as a critical gateway to STEM success but is often ineffective and can impede student progression. Addressing the systemic marginalization of the "new majority" of undergraduates, who represent rich sources of untapped talent, necessitates more robust approaches to training and supporting these students in STEM.

Key takeaways from the literature

1. **Traditional Remedial Education is a Major Barrier:** The traditional system of developmental or remedial education, especially in mathematics, is identified as a critical obstacle to STEM success and persistence. Evidence suggests that traditional remedial coursework often has little positive impact on long-term progression and can even hinder degree completion by being time-consuming, costly, and causing students to drop out before reaching college-level courses. Placement exams are also not always accurate predictors of success.

2. **Mathematics is a Critical Gateway:** Proficiency in mathematics is a key factor for success and persistence in STEM. Initial math courses like Algebra and Trigonometry may not adequately prepare students for advanced STEM coursework. Perceived preparation in mathematics is particularly significant for persistence in certain STEM fields like physical sciences, engineering, mathematics, and computer science.

3. **Academic and Social Integration are Essential:** Fostering students' integration into the college's academic and social systems is crucial for persistence. While social integration was previously downplayed for community college students, newer research disputes this, highlighting its importance. Programs and spaces that promote social integration can contribute to students' sense of belonging and connection to the institution.

4. **Psychosocial Factors are Key to Persistence:** Beyond academic skills, cultivating students' psychosocial well-being, including **self-efficacy**, **sense of belonging**, and **STEM identity**, is vital for success. Opportunities for students to reflect on their roles and identities can support their growth in competence as science students. Faculty also need support to increase their own self-efficacy in implementing culturally responsive pedagogies to support diverse students.

5. **Comprehensive Institutional Reform is Needed:** The literature strongly suggests that improving outcomes requires **systemic and comprehensive institutional reform** rather than focusing solely on student deficits. This involves changing structures, processes, and roles within institutions.

6. **Early Academic Performance Matters:** Consistent with broader research, first-semester GPA is a strong predictor of STEM persistence and degree attainment. Academic support immediately following entry is therefore important.

Interventions and actions

Effective interventions and actions to improve STEM outcomes for underrepresented groups, particularly in community colleges, span several interconnected areas. The literature strongly suggests that **effective interventions focus on integrated support.** Successful strategies include reforming developmental education through **accelerated models** and **co-requisite support**, where academic assistance is provided alongside college-level courses. **Contextualizing learning**, especially in mathematics, within students' fields of interest is a key principle. **Adaptive learning tools** like ALEKS have shown promise in increasing pass rates in developmental math, although careful implementation is needed. Such **comprehensive models can achieve significant results,** with highly structured programs that combine various support elements, such as dedicated advising, tutoring, success courses, linked courses, and financial support, like CUNY's Accelerated Study in Associate Programs (ASAP), have demonstrated substantial success in improving graduation rates for underprepared, low-income students. Some specific interventions include:

1. **Reforming Developmental Mathematics Education:** A critical gateway to STEM success, traditional remedial math is identified as a major barrier that can hinder progression and success. Effective actions include **reconceptualized developmental curricula** focused on essential skills for advanced mathematics and science, exploring **multiple measures** (like high school GPA and prior math background) instead of

relying solely on placement tests for appropriate course placement, and creating **structured pathways** in mathematics (like statistics or quantitative reasoning tracks) aligned with students' academic goals rather than a single, often lengthy, developmental sequence.

2. **Fostering Academic and Social Integration:** Integrating students into the college's academic and social systems is crucial for persistence. **Classroom-adjacent spaces** and programs like **Lunch & Learn (L&L)** can be particularly effective in supporting persistence by sustaining a supportive social community, providing access to information networks, and building STEM student self-efficacy and identity. Creating a sense of community among first-year STEM majors through **dedicated sections** or a **freshmen seminar** can promote social and academic relatedness.

3. **Cultivating Psychosocial Factors:** Programs that offer opportunities for students to engage in **undergraduate research** have been found to increase self-efficacy, science identity, and a sense of belonging in STEM. Programs that use vicarious learning can also lead to improvements in self-efficacy. Fostering student resilience when faced with performance roadblocks is also suggested.

4. **Improving Academic Advising and Structured Pathways: Structured degree pathways** and effective **academic advising** significantly impact persistence and completion rates. Providing students with clear course sequences to follow improves persistence and graduation rates. Advising is particularly important at community colleges due to the complexities of developmental credits, course transferability, and differing degree requirements. Colleges should provide **more resources to hire additional advisors** for STEM majors or provide training to existing ones. Making **multiple suggested pathways** readily available helps students navigate these systems, especially if they lack adequate advising.

5. **Implementing First-Year Experiences (FYEs):** Targeted academic programs for first-time students, such as FYEs, can help their persistence in STEM majors. FYEs designed to help students traverse potential barriers like academic preparation, acculturation, engagement, planning, and timely progress have been effective. These programs often **integrate literacy skill building** with discipline knowledge acquisition and incorporate **high-impact practices** like learning communities and peer mentoring. Participation in FYEs has been linked to improvements in **learning power**, which in turn predicted improved grades and persistence.

6. **Enhancing Faculty Capacity:** Efforts should move beyond "fixing" students and recognize the crucial role of faculty. Professional development for STEM faculty aims to increase awareness of and self-efficacy with **culturally responsive pedagogy**.

Implementing culturally responsive teaching practices and integrating them into the curriculum are necessary, as programs alone may be insufficient without these efforts.

Related metrics and indicators:

Several key metrics can be used to measure success in improving STEM outcomes for underrepresented groups, particularly within community colleges:

1. **Persistence:** This is a frequently cited metric, referring to a student's continued enrollment in a STEM pathway or at the institution itself. Specific measures of persistence include semester-to-semester persistence and remaining in a STEM educational or career pathway.

2. **Academic Performance/Success:** This is measured through various indicators:
   - **Grade Point Average (GPA):** Overall GPA and first-semester GPA are significant predictors and outcomes. Mean GPA for program participants is a comparison point.
   - **Performance in Gateway Courses:** Success and persistence in critical "gateway" courses, especially in math and chemistry, are key. This includes likelihood of progressing to the next course in a sequence (e.g., precalculus-2 from precalculus-1). Performance in science coursework can also be measured. Earning a C or higher in specific courses indicates success.
   - **Credit Production Rate:** The percentage of attempted credits that are successfully completed.
   - **Completion of College-Level Coursework:** Progressing through developmental education and completing college-level or "gatekeeper" math courses is tracked. Accruing college-level credits is also an outcome measure.

3. **Degree Attainment & Transfer:**
   - **Associate degree completion:** Measured as an outcome, particularly for community college students.
   - **Graduation Rates:** This includes associate degree graduation rates (often within a three-year window) and bachelor's degree graduation rates (often within a six-year window)
   - **Transfer Rates:** Transfer to four-year institutions is a crucial measure of success for community college students
   - **Completion of Transfer Degrees:** This is explicitly mentioned as a measure of STEM student persistence.

4. **Academic Progression:**

- **Disciplinary Persistence:** Whether a student remains in a STEM major or changes to a non-STEM discipline.
- **Vertical Mathematical Progression:** Improving progression through sequential STEM course sequences, starting with mathematics.

7. **Attrition:** This measures students leaving the institution altogether, which is particularly noted as a higher risk for some groups.

6. **Psychosocial Factors:** While not always direct *outcome* metrics in terms of completion, changes in these factors are measured as indicators of a program's impact on student development crucial for persistence:

- **Self-Efficacy:** Increases in self-efficacy, including STEM self-efficacy, may be tracked. Mathematics self-efficacy is particularly relevant for STEM career choice and persistence.
- **STEM/Science Identity:** Cultivating and influencing students' sense of themselves as part of the STEM community.
- **Sense of Belonging/Social Connectedness:** Fostering a feeling of integration and community within the institution or a specific program.
- **Resilience:** Students' ability to persevere when facing challenges.
- **Learning Power:** A construct encompassing various dispositions and attitudes impacting learning capacity and motivation, measured by tools like the Effective Lifelong Learning Inventory.
- **Non-cognitive and Metacognitive Skills:** Strengthening these skills is identified as important for student success.

7. **Faculty Engagement and Practice:** While primarily related to program implementation rather than direct student outcomes, measuring changes in faculty engagement and adoption of research-based or culturally responsive teaching approaches is seen as important.

Supporting literature

[NOTE: Many of these sources are on file at RPIE as PDFs and can be shared on request]

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