# RESEARCH, INNOVATION, AND TALENT

## WORKING GROUP DELIVERABLE

**The Research, Innovation, and Talent Working Group will focus on creating stronger ties between businesses and higher education by promoting industry-academic partnerships, experiential learning opportunities, and programs to meet market needs. In particular, the group will be charged with:**

- **Identifying strategies and best practices to increase research, development, and commercialization activities by our state's research universities.**
- **Developing effective industry-academic research and workforce development partnerships that lead to more research and employment opportunities for students.**
- **Highlighting successful practices that expand the number of students, especially women and underrepresented minorities, who participate in research and obtain STEM degrees.**
- **Determining effective methods for attracting and supporting diverse faculty and staff.**


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# OVERVIEW

The state plan for higher education, **Where Opportunity Meets Innovation**, emphasizes the importance of cultivating research, innovation, and talent to deepen and recapture our role as a leader in the innovation economy and effectively prepare students for success after college. This is described in more detail in the plan within a vision for a student bill of rights. The fourth element states, "Every student in New Jersey should have the opportunity to work with an employer, conduct meaningful research supervised by a faculty member, or access some other form of experiential learning before graduation." The eighth element states, "Every student in New Jersey should have high-quality , career-relevant academic programs that will prepare them to succeed in the global economy." The plan further argues that Colleges and Universities drive innovation, they are centers of research and development for new industry clusters, birthplaces for new ideas and companies, and provide rich environments for start-ups and creativity. "Knowledge creation is a fundamental aspect of colleges and university activity that supports commercialization, drives innovation, and ultimately strengthens the state's economy as a whole."

In furtherance of making this vision a reality, the **Research, Innovation, and Talent Working Group** was charged creating stronger ties between businesses and higher education by promoting industry-academic partnerships, experiential learning opportunities, and programs to meet market needs. In particular, the group will be charged with:

1. Identifying strategies and best practices to increase research, development, and commercialization activities by our state's research universities.
2. Developing effective industry-academic research and workforce development partnerships that lead to more research and employment opportunities for students.
3. Highlighting successful practices that expand the number of students, especially women and underrepresented minorities, who participate in research and obtain STEM degrees.
4. Determining effective methods for attracting and supporting diverse faculty and staff.

The group met six times in person from June 2019 through November 2019, where each meeting lasted for two hours each. Two chairs were appointed by Governor Phil Murphy to lead the working group, and they met regularly with OSHE and EDA staff in between meetings to further the work of the group. The larger working group broke up into four subgroups organized around each of the four charges stated above. Each subgroup met via conference call, in-person, and/or on-line meeting to further the work in between each of the plenary full working group sessions. Each subgroup first identified its final deliverable and created an action plan to reach that deliverable. The group was originally provided with an opening Power Point presentation provided by OSHE staff that provided a set of data/facts around each of the four charges in addition to handing out a full copy of the State Plan document to each member so that all members could have an initial starting point for discussion and deliberation around answering the charges. Each subgroup approached their work slightly differently but all ended up completing narrative deliverables that attempt to provide a resource for institutions and the State on how to further research, innovation, and talent development in the State of New Jersey and more specifically at its colleges and universities

# Increasing the number of women and underrepresented minority students graduating with a STEM degree

**Disclaimer:**

The views expressed in this document belong to the Working Group and do not necessarily reflect the official policy of the State of New Jersey. The content provided is intended to serve as a resource to help develop strategies to increase support for students at New Jersey's colleges and is provided in good faith. Due to time constraints, the Working Group notes the information may not be comprehensive and readers should take into account context for how the deliverable is used as well as further research that may be available after publication.

## Introduction

In order to fully grasp the different pathways, including onramps, and off-ramps that women and minority students move through in order to pursue a STEM degree, institutions must reflect on the data they collect and try to identify what the root causes are for low-numbers of underrepresented groups at graduation ("Nontraditional Career Preparation: Root Causes and Strategies | National Alliance for Partnerships in Equity" 2009). While there is a vast literature in the disciplines of student development, education, psychology, sociology, and other social sciences that have theorized why students do not persist through the pathway to the STEM degree, there are a number of best practices derived from evaluations and research on successful programs. In the following review, we provide some of the best practices that can be implemented at the institutional level to address issues observed in the data. These interventions are targeted toward the data benchmarking recommended in part one of this report and are organized by the different type of phenomena that can be seen in the data. A number of recent studies have recommended collecting these data in a standard format so that policymakers and higher education professionals can observe the progress being made toward diversity and equity goals (Perspectives: Strengthening The Effectiveness Of Minority-Serving Institutions, 2006; Hurtado et al. 2009).

## Successful Strategy #1: Revise gateway courses

Longitudinal studies of student persistence have identified different cultures and pedagogies in STEM introductory courses when compared to their humanities or social sciences counterparts (Estrada et al. 2016). Frequently, STEM introductory courses are referred to as "gateway courses" or "weed-out" courses intended to narrow the number of students that proceed to higher level courses. The assumption behind this kind of course sequencing is that only students that have been successful in introductory courses can be successful in the major. However, what is often not considered is that women and underrepresented students may not have received the same level of mentoring and prior academic exposure in relation to their more successful peers. These students often have the capacity for success in STEM but may feel discouraged because they feel they are struggling more than their peers.

Many colleges have had success with restructuring their first-year courses to ensure that promising students are placed in courses that are aimed in bringing underprepared and experienced students to the same level. For example, Harvey Mudd College in California increased the number of women declaring a major in Computer Science from 10% to 40% by changing the sequencing and structure of their introductory courses. According to their model, students without prior knowledge in programming were placed into a separate section from students with prior exposure. Researchers found that this helped to overcome issues around belonging that women often face in the computer science classroom and helped alleviate a

classroom environment where students with strong prior knowledge dominated the classroom (Alvarado, Dodds, and Libeskind-Hadas 2012; Corbett and Hill 2015).

Other programs have had success with redesigning the curriculum in introductory courses to provide a more engaging pedagogical experience. Integrating active learning pedagogies and providing more opportunity for discussion-based or peer-led team learning encourages students to engage in critical thinking. Other schools have reformulated laboratory curricula to engage research-based pedagogies that engage students in the discovery process where students engage in many of the same activities and thinking processes as scientists (Weaver, Russell, and Wink 2008). These interventions have found increasing interest in science, understanding the connection between science and everyday life, and seeing lab experiences as representative of real science experiences, and it has also shown a difference in the impact of laboratory experiences on future careers (Russell, Hancock, and McCullough 2007; Lopatto 2004).

**Successful Strategy #2: Provide cohort-based advising**

As noted in our discussion of benchmarking and data, it is critical to identify potential STEM students when they first arrive on campus so that they receive appropriate support and advising. It is also critical to identify these students early so possible points of attrition can be identified in the STEM majors. Community colleges like UCC require students to declare a provisional major, making it easier to outline the pathway toward success. Universities and colleges may have a variety of programs that support women and minorities but students need to be connected to them as early as possible. Institutions should utilize a combination of technology and one-on-one meetings to provide guidance to students. Automated messages are used to connect students with important resources at the right time (Kalamkarian, Boynton, and Lopez 2018).

**Successful Strategy #3: Professional development and support for faculty**

In studies of Historically Black Colleges and Universities, researchers have consolidated some best practices that help minority students find success in STEM majors. A great deal of these best practices center around supporting the time and investment needed for faculty to develop lesson plans and student centered pedagogy. Institutions that have been successful in supporting minority students and women in STEM majors communicate to their faculty that teaching and developing pedagogy are a priority and provide ample time for faculty to develop these skills. Therefore, providing adequate resources for faculty to developing innovative and engaging lesson plans can help support women and minorities in STEM fields (Estrada et al. 2016; Gasman, Nguyen, and Commodore 2017).

**Scenario 1: Students declare major but do not persist to graduation**

When controlling for academic preparation, underrepresented students are more likely to drop out of STEM majors than their White peers. Many of the strategies provided above can help support URM students persist, but additional programming is needed to support URM students. For example, Spelman College in Atlanta, Georgia whose students are women of color is the top producer of African-American women STEM undergraduates who go on to receive science doctorates since 2008. Spelman uses a freshman summer science program, research experiences, and faculty mentoring to retain students. Spellman found that by "encouraging students to realize their academic potential by embracing their ethnic and gender identity has resulted in more than 22% of graduates obtaining advanced STEM, medical, and allied health degrees" (Jackson and Winfield, 2014, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5008901/).

The Meyerhoff Scholars Program at the University of Maryland also includes a summer bridge program, building networks of peer support, tutoring, and personal advising (Summers and Hrabowski, 2006; Lee and Harmon, 2013). Using these elements the program reduced student isolation and low motivation that may result from unsupportive learning environments. They produced more than 1,000 STEM undergraduates since 1989, 209 of whom have received PhDs, and 70% of whom are from URM groups. These programs all help to retain talented URM students in STEM that might have otherwise declared a different major.

While research on the benefits of industry internships is limited, some research suggests that these experiences complement classroom learning (Thiry, Laursen, and Hunter 2011). Work experiences give students the real-world knowledge about careers and help to clarify future goals. Other research suggests that women and minority students struggle with developing identities as scientists and engineers because they often conflict with their identity as a woman or a minority (Ibarra 1999; Ibarra and Obodaru 2009). Therefore, having positive experiences as a STEM professional can help with managing these conflicting identities. However, the quality of these experiences is of importance. If students are not exposed to quality STEM careers they may lose interest in their major and abandon their career goals.

**Scenario 2: Few diverse students arrive on campus intending to declare a STEM major**

Many studies of K-12 students have found that when controlling for socioeconomic status, women and women of color are more interested in STEM than their male peers (Chen and Soldner 2013). However, many of these young people do not pursue STEM opportunities in higher education. Colleges can encourage underrepresented groups to pursue STEM at their institutions by providing summer programs and outreach opportunities where middle and high school students can engage with college campuses. These programs can also assist underrepresented minority students with personalized academic programs and support, and pre-training to prepare students for success.

Career and Technical Education (CTE) programs, offered at high schools and community colleges, provide credentials needed for STEM careers. Institutions of Higher Education benefit from partnering with STEM CTE programs and helping to develop the pipeline for students

entering STEM degree programs. CTE educational programs provide a career-focused perspective that may appeal to diverse students that prefer a real-world understanding of STEM skills and career pathways. These programs also collaborate with local Workforce Development Boards that ensure students are gaining the skills they need for jobs available locally. Jumping directly into STEM programs at a university or community college may be daunting for students who are interested in STEM content or careers but have never been formally mentored toward this goal. CTE's emphasis on hands-on training and real-world job skills gives students a sense of what the career pathway looks like, which may be more appealing to a diverse group of students who are unaware of the actual options available to them (Miller and Hayward 2006).

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