The Chronicle of Mentoring & Coaching

The Chronicle of Mentoring and Coaching,
2025, Vol. 9, No. 3
doi.org/10.62935/s2405p

DE-INBRE The Impact of a State-wide Mentoring Network on Biomedical Research Capacity

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This case example demonstrates the impact of targeted and sustained investment in research infrastructure and mentoring on a research ecosystem. The Delaware IDeA Network of Biomedical Research Excellence (DE-INBRE) is a statewide partnership funded the National Institutes of Health IDeA program and the State of Delaware which seeks to broaden the geographic distribution of biomedical research activity across the USA to better prepare students for biomedical research careers. DE-INBRE aligns with existing research on mentoring's role in professional development, faculty success, and workforce diversification. Studies show that structured mentoring and research engagement increase persistence in STEM fields. Faculty development models emphasize the importance of early-career support, grantsmanship training, and infrastructure investment in fostering sustainable research programs. DE-INBRE's approach builds on these theories, creating a self-sustaining mentoring network that enhances research capacity and institutional competitiveness. The DE-INBRE network includes the University of Delaware (R1 institution), Delaware State University (HBCU R2 institution), Delaware Technical Community College (community college network), Nemours Children's Health (pediatric healthcare system) and the Christiana Care Health System (large non-profit hospital system). As students need training sites, DE-INBRE also supports early career faculty with mentored research funding, grantsmanship training, and new technologies to build sustainable research programs that train the next generation of biomedical researchers. Since 2002, DE-INBRE has trained over 1,000 undergraduates and supported more than 100 faculty members who have secured hundreds of millions of dollars in additional research funding and published 100s of related scientific papers. Program alumni contribute to Delaware's biotechnology, public health, and academic sectors, while faculty beneficiaries now mentor the next generation of researchers. DE-INBRE underscores how sustained investment in mentoring and training fosters the self-sustaining research ecosystem needed to strengthen the biomedical workforce.

Keywords: Research infrastructure, mentoring undergraduates, faculty mentoring, capacity building

Acknowledgements: DE-INBRE is supported by the National Institute Of General Medical Sciences of the National Institutes of Health under Award Number P20GM103446 and the State of Delaware. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the State of Delaware.

Introduction & Literature Review

Mentoring can contribute significantly to the organizational performance of all stakeholders in academic settings. Previous studies have shown that mentored undergraduates achieved higher GPAs, complete more credit hours per semester, and had significantly lower dropout rates compared to non-mentored peers (Campbell & Campbell, 2007). Graduate student mentoring can impact career decisions and academic success (Pella & Carinici, 2024). Faculty mentoring is associated with greater job satisfaction, grant funding success, and likelihood of promotion (Efstathiou et al., 2018) while supporting professional identity formation (Krishna et al., 2024). The resulting improvements in student outcomes, faculty success, and retention align with the top organizational goals of academic settings.

Mentoring may be particularly important in science, technology, engineering and math (STEM) research fields, which commonly train new researchers using an apprenticeship model. Studies show that structured mentoring and research engagement increase persistence in STEM fields for both students and faculty. For students, hallmarks of effective programs include a cohort model (Hansen et al., 2024) alongside structured faculty and peer mentoring (Maton et al., 2016). While the literature provides a sense of the activities

and supports required for effective mentoring, the mechanisms for providing sustainable support to create persistent change are comparably less studied. This case study illustrates one example of how targeted investments can foster and sustain a supportive and successful research ecosystem.

DE-INBRE Network & Programs

The National Institutes of Health's (NIH) Institutional Development Award (IDeA) is a Congressionally mandated program designed to provide infrastructure, training, and research support for states and territories that have been historically underfunded by NIH (Bothner et al., 2025). The IDeA program currently supports six main funding mechanisms, including the IDeA Network of Biomedical Research Excellence (INBRE) program which seeks to expand the geographic distribution of biomedical research activity across the United States by supporting core facilities (e.g. fee for service organizations embedded within research institutions that foster shared access to expensive equipment such as confocal microscopes or specialized expertise such as custom molecule synthesis) , data science training, investigator pilot awards, and funded undergraduate research experiences. The overall goal of the INBRE program is to ensure that undergraduates enrolled at all institutions of higher education located in IDeA states are prepared for biomedical research careers.

The composition of INBRE networks varies from state to state depending on the types of institutions of higher education and research foci that are present (Lessard et al., 2021). Delaware INBRE (DE-INBRE) is a statewide partnership funded by both IDeA and the State of Delaware that was founded in 2004. Overall, DE-INBRE supports a range of activities that contribute to mentoring statewide. While each activity is tailored to the needs of the faculty and students it serves, they all contribute to the overall mission of developing a sustainable ecosystem capable of fostering high-quality biomedical research activity. The most significant activities for DE-INBRE include the Developmental Research Project Program (DRPP), the Student Research Program (SRP), infrastructure for biomedical data science (Data Science Core, DSC) and mechanisms to enhance access to cutting-edge research instrumentation (Centralized Shared Resources Core, CSR).

DE-INBRE Network

DE-INBRE Lead Institution

The University Delaware (UD) UD is a state-assisted, private institution which enrolls approximately 19,000 undergraduates and 4,000 graduate students. It is among the 3% of universities ranked by the Carnegie Foundation as a Research 1 "Doctoral University with Highest Research Activity" and is among the top 100 institutions for Federal Science and Engineering Obligations, even though UD lacks a medical school. UD has ten colleges, six of which are home to NIH-funded investigators. It also runs three Associate of Arts campuses located across the State of Delaware with full articulation with UD four-year degrees.

DE-INBRE Network Institutions

Delaware State University (DSU) is a primarily undergraduate institution (PUI) and historically Black college or university (HBCU) which enrolls approximately 6,500 students. DSU is ranked by Carnegie as a Research 2 university (doctoral university with high research activity). DSU has five STEM-related PhD programs (neuroscience, optics, applied chemistry, applied mathematics, and interdisciplinary environmental science), while 45% of its undergraduates are enrolled in STEM and/or biomedically relevant degree programs.

Delaware Technical Community College (DTCC) is Delaware's sole community college with campuses across Delaware. Its Fall 2022 enrollment was 6,973 with 2,470 Associates of Science students. The Biological Sciences (129 students) and Biotechnician (18 students) Associates of Applied Science (AAS) programs have the closest interaction with DE-INBRE. The AAS in Biological sciences is a two-year degree that is articulated with bachelor's programs at UD and DSU that allows transfer with junior status. All science courses have required labs, many of which have course-embedded undergraduate research experiences (CUREs) either as semester-long activities or as individual units developed with DE-INBRE support.

Christiana Care Health System (CCHS), based in Newark, DE, ranks 21st nationally in hospital admissions across its three hospitals while educating more than 260 residents and fellows. CCHS works with DE-INBRE on faculty research development and undergraduate research training. Nemours Children's Health – Delaware (NCH) anchors one of the nation's largest pediatric health systems, managing over 10,000 inpatient and 560,000 outpatient visits per year. NCH provides student training initiatives and development of faculty-level researchers.

Structure of DE-INBRE

Support for Undergraduate Trainees

The DE-INBRE Student Research Program (SRP) provides mentored biomedical research experiences to Delaware's undergraduates as such experience is essential to pursue a research career (Lopatto, 2007). The program is managed by a faculty member with extensive experience in student and faculty mentoring and additional faculty-level training coordinators are employed at each training site. During the academic year, the SRP facilitates both course-based and individual research experiences (the student may receive academic credit or be paid for hours worked). During the summer, the SRP manages a full-time research internship program, SRP summer scholars (SRP-SS), which funds students to

conduct research full time over a 10-week period. The SRP-SS provides a "deep dive" into a research area while giving participants a glimpse into biomedical research careers.

Mentor Recruitment

Each fall, mentors are recruited from all biomedical research non-profits across Delaware. Investigators apply to be mentors by providing contact information and an abstract outlining possible undergraduate research projects. Program requirements. While scholar responsibilities depend upon the project, all are expected to be treated as scientists-in-training who work on bona fide research projects that culminate in formal poster presentations. SRP leadership at all partner institutions works hard to establish a strong rapport with both students and mentors to help them create strong working relationships. SRP-SS participants are encouraged to continue their research projects during the academic year (for either pay or academic credit). It is common for these students to work in their research mentor's laboratory for 2+ years.

Structure of DE-INBRE

Support for Early Career Faculty Members

The Developmental Research Project Program (DRPP) supports research grants studying problems involving all research domains inclusive of NIH-relevant basic, clinical, and data sciences. All DRPP investigators are expected to engage undergraduate, graduate, and/or post-doctoral trainees in their research as they advance towards research independence. DRPP investigators are prioritized for placement of SRP trainees while DRPP investigators also receive training in mentoring best practices (Pfund et al., 2015; Byars-Winston et al., 2018) given by facilitators trained by the Center for the Improvement of Mentored Experiences in Research (CIMER). DRPP investigators also present posters and/or oral presentations at various DE-INBRE events, including an Annual state-wide Research Conference.

Proposal solicitation and grantsmanship mentorship. Requests for applications are widely disseminated across the Delaware research community two to three months prior to the deadline using numerous avenues of communication. As many DRPP applicants are naïve to the NIH grants process, the DRPP director (an established NIH funded investigator) conducts introductory seminars to educate applicants on the standard NIH grant format as well as research compliance requirements including Institutional Review Board (IRB) and Institutional Animal Care and Use Committee (IACUC) approvals, clinical trial form entries, and data management and sharing plans, and recordings of these seminars are hosted on YouTube as part of the overall research mentoring program for applicants. Applicants are encouraged to seek out pre-reviews of the proposed specific aims and grant body to ensure that the application effectively communicates the research to potential reviewers.

Plans for Recruiting and Matching Mentors to Applicants

Once an investigator has expressed interest in submitting a DE-INBRE grant application, they are required to identify a senior researcher who can mentor the development of their research proposal, and downstream funding applications. DE-INBRE leadership will recommend appropriate mentor(s) if needed. All potential applicants are encouraged to identify a mentor two months prior to the application deadline so there is sufficient time to get proposal advice and develop a robust mentoring plan. All mentors are encouraged to participate in workshops on best mentoring practices held by DE-INBRE and other entities.

Post award mentoring of DRPP-funded Investigators Mentor-investigator pairs develop a mentoring compact to set the ground rules for regular mentoring sessions. DRPP project mentors check in regularly with investigators to discuss research progress/barriers so solutions can be found, and to plan publications and new grant submissions to seek extramural funding. Discussions also explore professional challenges, and any other situations that may be barriers to professional success. Both DRPP mentors and their mentees (likely future SRP mentors) are encouraged to participate in mentorship training (from CIMER trained facilitators or via other programs) to optimize the mentoring relationship. DE-INBRE leadership provides additional guidance to investigators including review of career/research mentoring plans. Annual surveys are completed to ensure that the mentoring relationship is productive.

Tracking and Evaluation

The DE-INBRE maintains a robust tracking and evaluation approach, including both qualitative and quantitative methods, to document the impact of the network. This information is also used for program improvement purposes across the network.

Faculty Tracking and Evaluation Faculty recipients of pilot and seed funding participate in annual reporting, providing both narrative progress on their projects and documentation of outputs such as manuscript submissions, scientific presentations and grant submissions. Since 2022, this tracking has been facilitated by Piestar, a commercial product designed to gather tracking information from NIH-style grants. Faculty receive reminders to complete reporting directly from Piestar, and forms are customized to each faculty member. DE-INBRE's administrative team receives, reviews and aggregates data both within and across years for the purposes of internal and external reporting focusing on measures of research career success such as publications, grant funding, promotion in academic rank, and

retention in the profession.

Student Tracking and Evaluation

Student participants in the Student Research Program complete pre- and post-program surveys and their academic and professional trajectories are tracked using publicly available sources (e.g., LinkedIn and Google searches) conducted annually. Students' experience with mentoring is assessed through post-program surveys.

Results

Delaware's first IDeA program capacity building grant was funded in 1996 to support research infrastructure and faculty development at UD. This expanded into DE-INBRE which was founded in 2004 with federal, state, and partner institution funding with the goal of building Delaware's biomedical research capacity via support for multi-user core facilities, technology training, pilot grant funding for early career faculty members, and support for paid undergraduate research internships. DE-INBRE's federally mandated success measures include 1) increased number of biomedical research laboratories capable of supporting undergraduate research experiences, 2) career progression of faculty supported on DE-INBRE pilot grants, 3) retention of DE-INBRE supported undergraduate researchers in professions relevant to biomedical research, 4) growth in the number of investigators trained in biomedical data science methods and pursuing research in this area, and 5) development of sustainable core facilities that train faculty and students in cutting edge research methods. Inclusive and respectful communication between partner organizations and mentoring strategies targeted to the needs of each institution and type of DE-INBRE program participant have been essential to establish and sustain the program's 20-year-long mission supporting Delaware's biomedical research ecosystem.

Faculty Mentoring Networks Grow Institutional Research Capacity

Delaware's first NIH IDeA grant (1996), the immediate precursor to the INBRE program, supported faculty hiring, mentoring, and infrastructure for UD molecular biology research. This initial investment made a lasting impact with all five hires promoted to Full Professor, several taking on major leadership roles including that of department chair, center director, and the current DE-INBRE principal investigator. In 1995, the year before these efforts began, Delaware investigators received only 20 R-type NIH grants, whereas 124 of these awards were held by Delaware investigators in 2023, including 21 to former DE-INBRE DRPP investigators. Over this same period, total NIH research funding to Delaware has increased nearly 19-fold – from $6.4M awarded in 1995 to $119M in 2023 (UD: $71M, Nemours: $14M, DSU: $17M, CCHS: $1.7M, others: $15M). Since DE-INBRE's inception, the Developmental Research Project Program (DRPP) has supported 111 investigators, with 80 still working in Delaware and contributing to its biomedical research capacity. Sponsored program expenditures at UD have increased to $221.7 million in fiscal year 2022, from $139.9 million in 2013, reflecting a more than 58% increase in its research volume in ten years. DRPP alumni include the current UD Provost, numerous department chairs, the mentoring lead for Nemours, and the leads of several other NIH-funded (COBRE) research capacity programs demonstrating how mentoring of early career faculty can lead to professional and institutional success.

Mentored Student Research Enhances Outcomes and Biomedical Workforce Participation

Since 2002, when robust tracking began, more than 1,000 undergraduates have participated in the SRP. During the period 2002-2020, 96% of past participants were on-track to completing or enrolled in an undergraduate degree, and 80% of students were pursuing biomedical-related careers. Numerous SRP alumni work in Delaware's biotechnology and health care sectors and recently a former SRP student accepted a tenure track faculty position at UD, demonstrating the impact of SRP training on Delaware's STEM workforce. In qualitative interviews, students explained how their SRP experience contributed to their interest in pursuing biomedical research careers. Themes across interviews suggest that the SRP experience allows students to learn first-hand about the experience of conducting research, contribute substantially to research teams, and experience multiple levels of mentoring which helps them understand diverse pathways to biomedical-related careers. According to one former student, "Before, I never even knew research was an option for me. I've loved it ever since!"

Discussion

Across multiple organizations, activities and years, DE-INBRE achieved successes for students and faculty that resulted in institutional transformation. Faculty participants in DRPP were successful in project completion, shared their science through publications and presentations and secured additional funding. These outcomes are consistent with the literature suggesting that faculty mentoring drives successful grant funding and promotion (Efstathiou et al, 2018).

On the student side, and consistent with the previous literature (e.g., Campbell & Campbell, 2007), undergraduate students participating in the DE-INBRE SRP reported high levels of academic achievement and retention following their participation in the program. However, DE-INBRE did not just impact individual careers. It also reduced the administrative and logistical barriers that siloed Delaware's institutions of higher education, research hospitals, and state agencies,

changing Delaware's research culture. Also, DE-INBRE's SRP routinely places students in research internships outside of their home institution, with 24 of 77 SRP students placed cross-institutionally in the summer of 2023 alone.

The growth in research culture and infrastructure enabled by the success of DE-INBRE has resulted in institutional transformation across the network. Institutional commitments to research and teaching in STEM disciplines contribute to the long-term sustainability of these efforts. Across this case study, several lessons can be learned and applied to other networks seeking to establish and sustain mentoring across stakeholders. First, using a holistic approach to mentoring, including multi-level and multi-modal mentoring was critical to the success of DE-INBRE. The combination of formal mentors, informal mentors, and peer- and near-peer mentors provided the type of support that enabled success in a sustainable manner. Investigators across DE-INBRE programs are offered these supports at different times in their career and can contribute to future generations as mentors.

Secondly, the DE-INBRE approach is flexible and responsive to both the diverse needs of the network organizations, which vary considerably in research focus and intensity, but are also able to adapt to improve engagement and outcomes across the network. One illustrative example is the pivot of SRP activities to those accomplishable in a remote format during COVID lockdowns and customized student matching that "meets students where they are."

Lastly and most importantly, the DE-INBRE model integrates mentorship across career stages. One example is how DRPP investigators receive mentorship from DRPP leadership and their identified project mentors but these same investigators also serve as mentors to undergraduate students in the SRP. All involved receive professional development and support to develop their mentoring skills, resulting in a shared understanding of mentoring language and approach across the network. This approach could be replicated in other programs, even on a smaller scale.

While DE-INBRE has generated meaningful successes, there are limitations to this approach. One example is that the program has been enabled by long-term funding from the NIH and the State of Delaware. Without those consistent investments that investigators and students could count on, this program would have a more limited impact. In other contexts, where such funding is not available, it may be difficult to develop robust and effective mentor networks at this scale. That said, the key lessons from this case study can still apply, even if the scale or magnitude of the programming is more limited as supportive mentoring interventions are focused on the success of individuals not networks.

Conclusion

This case study has described the design, functioning and outcomes of the DE-INBRE model of integrated and sustainable mentorship. This approach is consistent with the theme of developmental networks for wellbeing, especially as it relates to the impact of mentoring on sustained individual and organizational performance and creation of a collaborative culture. The long-term investments in mentoring and research training enabled by DE-INBRE foster the type of self-sustaining research ecosystem that is needed to strengthen the biomedical workforce both in Delaware and nationally.

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