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Interventions to Optimize Mentoring Relationships for Diverse Biomedical Researchers

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Abstract

The articles in this special issue provide insights from a variety of mentoring interventions that were implemented across the NIH Diversity Program Consortium (DPC). Many of the articles highlight examples of how the *Entering Mentoring* and *Entering Research* curricular materials, available through the National Research Mentoring Network (NRMN), were adapted and implemented for research mentors and research trainees at Building Infrastructure Leading to Diversity (BUILD) institutions. Other articles report the outcomes of programs developed and offered more broadly by the NRMN. This overview provides background information on NIH DPC-wide efforts and the *Entering Mentoring* and *Entering Research* curricula.

Introduction

A complex set of historical and social factors have contributed to a lack of diversity in the biomedical research workforce in the United States, which has created a challenging and at times unwelcoming environment for aspiring researchers from diverse backgrounds. The goal of the National Institutes of Health Diversity Program Consortium (NIH DPC; https://www.diversityprogramconsortium.org/) is to address these challenges and to enhance diversity in the biomedical research workforce through development, implementation, assessment, and dissemination of innovative and sustainable approaches to student engagement, training and mentoring, faculty development, and development of institutional research training infrastructure.

Established in 2014, the NIH DPC is a national collaborative of experimental training awards designed to investigate ways to attract and retain students from diverse backgrounds into the biomedical research workforce and to encourage them to become future contributors to the NIH-funded research enterprise. The first set of NIH DPC funded initiatives included three types of awards: 1) ten Building Infrastructure Leading to Diversity sites (BUILD); https://www.diversityprogramconsortium.org/pages/build); 2) one National Research Mentoring Network (NRMN; https://nrmnet.net/); and 3) one Coordination and Evaluation Center (CEC; https://www.diversityprogramconsortium.org/pages/cec). The

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BUILD institutions incorporate and evaluate innovative methods to recruit, engage, and prepare diverse pools of students for success in biomedical research careers, including both direct student programming and faculty/staff professional development. The NRMN develops and tests on-line and in-person resources and trainings to provide support for the development of positive and productive research mentoring relationships for diverse research trainees across career stages. The CEC provides operations and data coordination to the BUILD and NRMN programs and is conducting a longitudinal evaluation of the programs (https://www.diversityprogramconsortium.org/briefs/pages/).

Mentor and Research Trainee Interventions at BUILD Sites

Evidence-based mentor and mentee trainings developed by the NRMN have been adapted and implemented by some BUILD sites to create unique interventions that serve their institutions' needs (Table 1). Other BUILD sites have developed and implemented their own programs. Descriptions of several of these interventions were first presented as a Deeper Dive session at the 2018 Understanding Interventions Annual Conference.

In this special issue, articles developed from those 2018 presentations are presented. Ott and colleagues at the University of Maryland, Baltimore County present outcomes from their BUILD program mentee training intervention, which integrates an online badge system with a course based undergraduate research experience. Abeywardana and colleagues at California State University, Long Beach and Morales and colleagues at the University of Texas El Paso describe their BUILD programs' near-peer and peer mentoring interventions, respectively. Keller and Lindwall present data from Portland State University's BUILD multiple mentor model intervention that explains the different roles that different types of mentors play in their BUILD program.

Finally, Young and Storme describe an intervention designed to develop the skills of experienced mentors in their BUILD program at California State University, Long Beach. In addition to these five articles on novel mentor and mentee training interventions are two articles from the NRMN's Mentor Training Core (MTC). The first article from House and colleagues describes the MTC's efforts to increase the nation's capacity to implement mentor and mentee trainings through the Master Facilitators Initiative. The second article, written by Rogers and colleagues, describes the effect of mentor training dosage and previous mentoring experience on mentoring effectiveness.

Besides implementing trainings, some BUILD site leaders also served as consultants, developers, pilot testers and contributors to the most recent editions of the *Entering Mentoring* and *Entering Research* curricula. Their engagement was key to ensuring that the curricular materials met the needs of students from diverse backgrounds, in particular those from historically underrepresented groups in biomedical research careers.

The remainder of this article presents background information on the NRMN's efforts to support and understand how positive and productive mentoring relationships work, the *Entering Mentoring* and *Entering Research* curricula and associated assessment instruments, and the NRMN facilitator workshops to train professionals to implement the curricula.

The National Research Mentoring Network (NRMN)

Strong evidence exists that mentoring is a critical developmental factor associated with a successful biomedical research career, yet in a study of barriers to NIH funding, minority investigators reported inadequate mentoring as a major obstacle to their success (Ginther et. al., 2011). The National Research Mentoring Network (NRMN) was established to respond to this gap in mentoring support.

One goal of NRMN has been to establish a highly networked set of motivated and skilled mentors and to link them to diverse biomedical research trainees at all career stages across the country (MyNRMN, https://nrmnet.net/mynrmn/). Another goal has been to develop, test, and disseminate a range of approaches aimed at optimizing mentoring relationships (https://nrmnet.net/mentorship-training-programs/), and developing junior researchers' grant writing skills (https://nrmnet.net/grantwriting-coaching-groups/). In collaboration with the CEC, the short-term and longer-term outcomes of these efforts have been evaluated (Guerrero et al., 2017), and analysis of results from this national, longitudinal data collection are ongoing. For comprehensive reviews of undergraduate research, graduate education, and the science of mentorship in STEMM beyond the NRMN outcomes, see the National Academies of Science, Engineering and Medicine reports (NASEM, 2017. 2018, 2019).

NRMN Mentorship Training Core (MTC).

"Mentorship is a professional, working alliance in which individuals work together over time to support the personal and professional growth, development, and success of the relational partners through the provision of career and psychosocial support" (NASEM, 2019). These relationships are at the heart of the biomedical research apprenticeship training model. Therefore, the quality of these relationships is an important factor in determining the success and persistence of aspiring research trainees (McGee, 2016; NASEM, 2017, 2018, 2019). The NRMN Mentor Training Core (MTC) was created to provide evidence-based, career-stage appropriate, training for mentors and research trainees that supports the development of positive and productive mentoring relationships and, in turn, increases persistence of research trainees along a biomedical research career pathway (Sorkness et al., 2017).

The work of the MTC was grounded in a robust conceptual model of persistence focused on social cognitive career theory (Lent, Brown & Hackett, 1994; Lent et al., 2005; Gainor & Lent, 1995; Bakken et al., 2010; Byars-Winston et al., 2010; Byars-Winston et al., 2015) and formation (and reformation) of science and cultural identities across developmental stages (Byars-Winston, 2018). This model addresses the bi-directionality of the mentoring relationship and sets forth specific, measurable standards for the effectiveness of these relationships. Its goal was to extend and improve upon a strong foundation of successful process-based, community-building approaches to training, which are adaptable for use in multimodal formats and built to be scalable and sustainable.

The MTC brought scholars and practitioners from across the country together to collaborate on developing, adapting, testing, and disseminating training interventions for research mentors, as well as research trainees across the career spectrum (undergraduate, graduate,

postdoctoral and junior faculty members). Many of these interventions were built upon the evidence-based curricula *Entering Mentoring* (Pfund, Branchaw and Handelsman, 2015) and *Entering Research* (Branchaw, Butz and Smith, 2020). An iterative process of development, adaptation, testing and revision was used to develop the mentor and mentee training resources that underlie most, but not all, of the interventions reported in this special issue (Figure 1).

To build capacity for training, the MTC developed and tested facilitator training workshops (https://sites.google.com/view/nrmnfacilitatorcertification/home) to prepare research training program directors and other leaders in the biomedical research community to implement *Entering Mentoring* and *Entering Research* training at their own institutions (Spencer et al., 2018; Branchaw, Butz and Smith, accepted). In addition, the MTC defined attributes of effective mentoring relationships to guide mentors and research trainees in navigating their relationships. These attributes align with the defined mentoring competencies and areas of trainee development that serve as the foundation of the *Entering Mentoring* and *Entering Research* curricula (Pfund et al., 2016).

Mentor and Research Trainee Curricula.

The *Entering Mentoring* and *Entering Research* curricula are organized by mentoring competencies and areas of research trainee development, respectively (Table 2). This organization allows for maximal flexibility in implementation because facilitators can mix and match modules and activities based on the competencies or areas of development they wish to address in their training intervention. *Entering Mentoring* curricular materials are organized by modules based on the mentoring competencies. The *Entering Research* curriculum includes 96 individual activities that are organized by the seven area(s) of trainee development and trainee career stage.

Assessment of Mentor and Trainee Learning.

Measuring whether and to what extent the research mentors and research trainees participating in the *Entering Mentoring* and *Entering Research* modules and activities are developing the competencies or achieving the stated learning objectives is critical to evaluating the success of interventions that incorporate the curricula. To this end, instruments were created and evidence of validity collected with diverse populations to measure and track the development of 1) research mentoring skills (competencies), 2) research trainee skills (areas of trainee development), and 3) the quality of the research mentoring relationship.

Two pairs of assessment instruments were developed to measure development of mentor competency (Mentoring Competency Assessment, MCA; Fleming et al., 2013) and trainee skill and knowledge (Entering Research Learning Assessment, ERLA; Butz and Branchaw, accepted). Each instrument includes a mentor survey and a trainee survey to allow both parties to self-assess their own competencies, skills and knowledge, as well as assess the competencies, skills and knowledge of their partner in the mentoring relationship. Questions asking about the quality of the mentoring relationship are also included. Alignment of the mentor-trainee scores can be used as indicators of the health of the mentoring relationship.

In addition, the *Entering Research* curriculum also includes specific assessment tools (e.g., rubrics) to objectively assess a trainee's research products (e.g., research posters and oral presentations; research experience reflection assignments). The MCA and ERLA are available for use by research training programs through the Center for the Improvement of Mentored Experiences in Research (CIMER) Assessment Platform (https://cimerproject.org/training-evaluation/). The instruments provide information that research training program directors need to assess whether the mentors in their programs are providing high quality mentoring and whether their research trainees are developing the skills and knowledge they need to be successful in pursuing a research career.

Training Biomedical Professionals to Implement Training for Mentors and Trainees

While providing direct mentor and research trainee workshops is a goal of the NRMN, a larger transformative goal has been to foster a culture of mentoring and to build institutional capacity for optimizing mentoring relationships that can transform the national biomedical enterprise (Rogers et al., 2018; Spencer et al., 2018). Therefore, in addition to creating a group of Master Facilitators who can directly train mentors and research trainees across the nation (House et al, this issue), the MTC also developed two-day facilitator training workshops to empower leaders in the biomedical research community to implement the training at their own institutions. As of February 2020, 1,110 professionals from across the nation had been trained to implement *Entering Mentoring* and 206 to implement *Entering Research* (https://cimerproject.org/). Included in these trained facilitators are leaders at the BUILD sites reported in this special issue.

During the *Entering Mentoring* two-day facilitator training workshop participants engage in mentor training themselves, then learn to facilitate the training and develop strategies for local implementation and evaluation. During the *Entering Research* two-day facilitator training workshop participants use the Backward Design process (Wiggins et al., 1998) to build a custom curriculum. They define learning objectives for their trainees, then select activities and assessments that align with those objectives. They also learn to facilitate *Entering Research* activities by practicing active learning pedagogical approaches and develop implementation and evaluation plans.

Evaluation data collected immediately after the facilitator training workshops and in follow up surveys show that the workshops effectively prepare biomedical research leaders to implement mentor and mentee training at their home institutions and that the majority implement a training within 12 months of completing facilitator training (Spencer et al., 2018; Branchaw, Butz and Smith, accepted).

Summary

Given that mentoring is a critical developmental factor associated with successful biomedical research careers, especially for diverse populations of trainees, integrating mentor and mentee training into programs to support research mentoring relationships is essential. However, one size does not fit all. The articles in this special issue provide

a variety of examples of ways in which training for mentors and research trainees (*Entering Mentoring, Entering Research*, and other trainings) can be implemented. Important information that leaders in the biomedical research community need to make decisions about the types and durations of training interventions that would work best with their populations is also highlighted. Although the intervention development and testing reported in this special issue was carried out primarily by NRMN and BUILD scholars, there is much more work to be done. Contributions from the broader community are invited to develop this emerging field and study the impact of interventions that optimize mentoring relationships and diversify the biomedical and behavioral research workforce.

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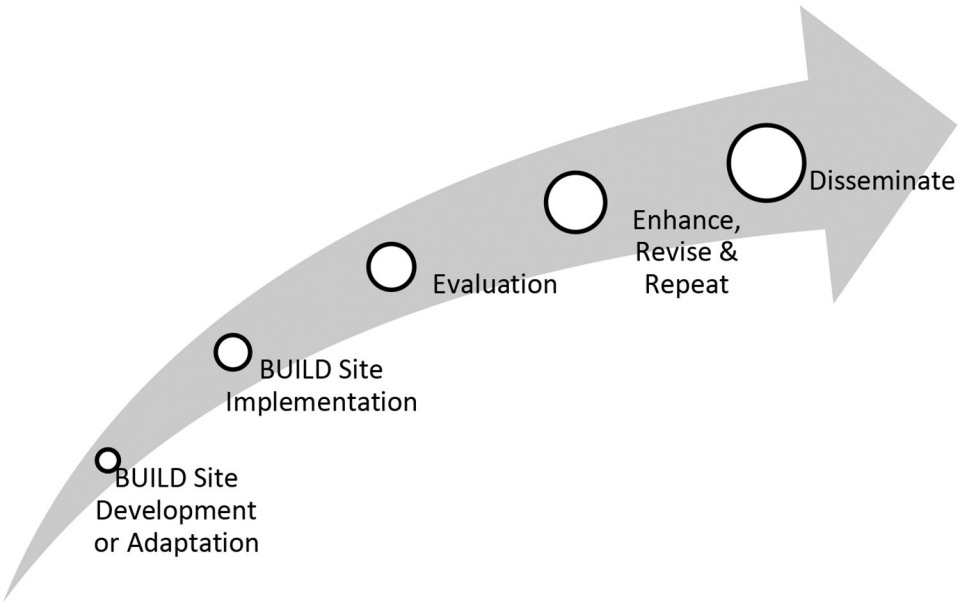

Figure 1.
Process of NRMN-MTC resource development, adaptation and implementation in collaboration with BUILD sites.

Table 1.

Brief overview of the NIH DPC Mentor Training Efforts

DPC Organization	Special Issue Article* or Training Program Description
BUILD: California State University, Long Beach	*Near-Peer Mentoring in an Undergraduate Research Training Program at a Large Master's Comprehensive Institution: The of CSULB BUILD *The BUILD Mentor Community at CSULB: A Mentor Training Program Designed to Enhance Mentoring – Skills in Experienced Mentors
BUILD PODER: California State University, Northridge	Mentors participate in a 16-hour Critical Race Theory training when they join the mentor pool, which is followed by three to four-hour trainings annually.
BUILD: Morgan State University	Lead and Near-Peer Mentors participate in a 6 to 8-hour mentor Bi-Annual workshop utilizing the *Entering Mentoring* curriculum.
BUILD EXITO: Portland State University	*Investigating a Multiple Mentor Model in Research Training for Undergraduates Traditionally Underrepresented in Biomedical Sciences
BUILD: San Francisco State University	SF State and University of California San Francisco partner to train mentors in annual 2-hour training sessions and to run a cross-institutional near-peer mentoring program.
BUILD: University of Alaska, Fairbanks	Full day mentoring workshops (6-8 hours), 2-3 times per semester; mentor discussion groups monthly, one hour, led by Research, Advising and Mentoring Professionals or guest speakers
BUILD: University of Detroit, Mercy	In-person event led by local faculty and staff who have been through NRMN's facilitator training. Consists of a) implicit bias awareness training; b) clear communication exercises using case studies about how conversations can be misconstrued based on context; c) setting expectations exercises and a discussion of mentor-mentee compacts.
BUILD: University of Maryland, Baltimore County	*Introduction to Research: A Scalable, Online Badge Implemented in Conjunction with a Classroom-Based Undergraduate Research Experience (CURE) that Promotes Student Matriculation into Mentored Undergraduate Research
BUILD: University of Texas, El Paso	*BUILD Peer Mentor Training Model: Developing a Structured Peer-to-Peer Mentoring Training for Biomedical Undergraduate Researchers
BUILD: Xavier University of Louisiana	Design and Implementation of a Mentor Training Program at Xavier University of Louisiana: Impact of and Lessons Learned
NRMN: Mentor Training Core	*The NRMN Master Facilitators Initiative: Building a community of practice to broaden program implementation.
NRMN: Mentor Training Core	*How much is enough? The Impact of Training Dosage and Previous Mentoring Experience on the Effectiveness of a Research Mentor Training Intervention

*Indicates article in this special issue.

Table 2.

Mentoring Competencies and Areas of Research Trainee Development

***Entering Mentoring*: Mentoring Competencies**	***Entering Research*: Areas of Trainee Development**
• Align Expectations • Address Equity and Inclusion • Articulate a Mentoring Philosophy and Plan • Assess Understanding • Cultivate Ethical Behavior • *Enhancing Work-Life Balance • Foster Independence • Maintain Effective Communication • Promote Mentee Professional Development • Promote Mentee Research Self-Efficacy*	• Research Comprehension and Communication • Practical Research Skills • Research Ethics • Researcher Identity • Research Confidence and Independence • Equity and Inclusion Awareness and Skills • Professional and Career Development Skills

*Not part of original curriculum, but added later

Pfund, Branchaw and Handelsman, 2015; Branchaw, Butz and Smith, 2020; https://cimerproject.org/#/