PDM Anthology: Perspectives from the Field

Building Research and Teaching Capacity of Early Career STEM Faculty at Historically Black Colleges and Universities (HBCUs)

January 2016

QUALITY EDUCATION FOR MINORITIES (QEM) NETWORK
HBCU-UP Education Research/Professional Development and Mentoring (PDM) Project: Enhancing Research Productivity of Early Career STEM Faculty at HBCUs

Supported by the National Science Foundation (NSF)’s Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)
ABOUT THE QEM HBCU-UP EDUCATION RESEARCH PROJECT: 
ENHANCING RESEARCH PRODUCTIVITY OF EARLY CAREER 
STEM FACULTY AT HBCUS

In 2010, the Quality Education for Minorities (QEM) Network received support from the National Science Foundation (NSF)’s Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) to conduct the HBCU-UP Education Research project: Identifying Minimal Conditions Essential to Enhancing Research Productivity of Early Career Faculty in Selected STEM Disciplines at HBCUs. QEM conducted the project from 2010-2015. Project interventions included the implementation of the QEM Professional Development and Mentoring (PDM) Program to facilitate participants’ career advancement and professional growth. The factors/conditions studied and project benefits include: release time (reduced teaching load) to conduct STEM research-focused activities; support for undergraduate research assistants; senior faculty research mentors; extensive professional development experiences; guidance in preparing and mentoring students as research assistants; and training in research proposal preparation as well as project implementation and management.

The PDM Program provided a cadre of STEM faculty from HBCUs with a series of professional development workshops and a peer support network as well as mentoring by experienced senior researchers. QEM collected data on a range of participant progress indicators: Research Proposal Submission and Success; Presentations; Publications; Mentoring Activities; Other Scholarly Activities, including career advancement (promotion and tenure); and Recognition/Honors. Analyses of the data show that PDM participants have made extensive progress in their career growth as a result of their participation in the QEM HBCU-UP Education Research project. STEM department chairs and other faculty/administrators also participated in the workshops or other project activities to ensure their involvement in the development and implementation of institutional action plans to sustain the PDM members’ career advancement and professional growth.

In February 2014, QEM produced a PDM Participant Profile Booklet, highlighting the HBCU faculty accomplishments, that was disseminated to a variety of stakeholders, including STEM deans, chairs, and other faculty on participants’ campuses. QEM’s development, publication, and dissemination of this PDM Anthology (November 2015) as well as a complementary STEM Research Mentoring Guide for Early Career Faculty (February 2016) will serve to advance knowledge about career advancement and support strategies for junior faculty at HBCUs, and other institutions with strong societal needs and community service foundations.

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ABOUT THIS DOCUMENT

QEM conducted the NSF-supported HBCU-UP Education Research project: *Identifying Minimal Conditions Essential to Enhancing Research Productivity of Early Career Faculty in Selected STEM Disciplines at HBCUs* from 2010-2015. Project interventions included: release time to increase participants' scholarly productivity in STEM research; support for their undergraduate research assistants and for materials/supplies; and implementation of the QEM Professional Development and Mentoring (PDM) Program.

From 2010-2015, the PDM Program provided a cadre of twelve (12) early career STEM faculty from seven (7) HBCUs with a series of professional development experiences as well as mentoring by senior STEM researchers. QEM collected data on a range of participant progress indicators over the five years and analyses show that PDM faculty made significant progress in their career growth as a result of project participation.

In project surveys, participants cited the significant release time provided as the condition most essential in enhancing their STEM research capacity and scholarly productivity. QEM invited the PDM cadre to submit manuscripts that offered their personal insights on the project interventions or other factors/conditions they found particularly beneficial to their career growth. The ten (10) manuscripts received have been compiled into this anthology.

*PDM Anthology: Perspectives from the Field* seeks to provide the PDM cadre, a peer network of STEM faculty at HBCUs, the opportunity to share their knowledge of STEM research, teaching, and outreach with peers as well as other faculty.

This document is available on-line at [http://qemnetwork.qem.org/PDM_Anthology.htm](http://qemnetwork.qem.org/PDM_Anthology.htm) to enable its dissemination to a wider audience of STEM scholars and teachers.
Beyond Expectations:
How My Involvement in the QEM/PDM Program
Played an Integral Part in My Growth and
Development from Assistant to Associate Professor

Natalie Arnett
Life and Physical Sciences Department
Fisk University
1000 17th Avenue N, Nashville, TN 37208

Summary
Life as an Assistant Professor at a Historically Black College/University (HBCU) is tedious due
to huge workloads, lack of guidance on how or where to obtain external funding, and no
mentorship. The QEM/PDM program was introduced to me at a time when the frustrations of
working at an HBCU were becoming overwhelming. The help that the PDM program provided
to me in terms of release time, mentorship training and assistance, and workshops was priceless
and gave me a newfound passion for teaching and research.

My transition from an Assistant to Associate Professor can be directly correlated to my
involvement in the QEM/PDM Program. QEM not only helped me refine my vision of where my
career was heading but also gave me the tools to accomplish my goals. The two areas of
assistance I found most effective in my development and growth were: research proposal
preparation/submission; and integration of research and education. Since becoming affiliated
with QEM/PDM, I have been awarded three grants totaling over one million dollars from the
National Science Foundation; I learned how to incorporate my research into my coursework; and
I have developed a mentoring network between the students and me that has led to their success
in the classroom and laboratory.

After I served as a teaching assistant in graduate school for two years, teaching truly had
no appeal to me as a profession. So when the opportunity to become an assistant professor
became available at the end of my graduate career while I dealt with a series of rejections from
various industrial jobs, I found myself between a rock and a hard place. Do I hold on for my
dream of becoming a research scientist at a large corporation, or do I teach? I chose teaching,
and though I thoroughly love being an educator, I have found that teaching at a historically Black
college/university (HBCU) has been extremely tedious.

Don’t get me wrong: teaching is one of the greatest professions. I especially love
teaching college students because I have the opportunity not only to introduce concepts to my
students but also to allow them to apply these concepts to formative research. However, this is
only a small part of the ultimate goal in a college professor’s career: TENURE. To achieve
tenure at my university, success in three areas—teaching, research, and service—are required. However, this becomes a challenge since heavy teaching loads, no release time, and involvement on numerous service committees are issues for most new assistant professors, making research almost impossible throughout the academic year.

A study by the Higher Education Research Institute in 1999 demonstrated that most professors spend approximately 59 percent of their time teaching, 23 percent of their time involved in service, and only 18 percent of their time conducting research. The lack of time designated to research can severely impede any assistant professor’s track toward tenure since most departments expect faculty to spend most of their time conducting research and generating external funding.

This is where my love/hate relationship with being an educator begins. At many HBCUs, faculty members are expected be everywhere, at all times, doing everything! The long hours and overwhelming demands, lack of infrastructure to conduct research, and low pay are some of the reasons why I initially did not want to become a professor. This is why being a part of the QEM/PDM program was pinnacle in my growth and success as a professor at an HBCU.

“The two areas of assistance I found most effective in my development and growth were: research proposal preparation/submission; and integration of research and education.”

The QEM/PDM program was introduced to me at a time when the frustrations of working at an HBCU were becoming too much for me to handle. I had already begun the process of looking for industrial jobs because it was more than I could handle and it was beginning to affect my family life as well. Some of the issues that I had to contend with included: huge workloads; poor management of funds; inability to obtain lab supplies; lack of guidance on how or where to obtain external funding; and no mentorship.

The help that the PDM program provided to me, in terms of release time, mentorship training and assistance, and workshops, addressed each of these issues and gave me a newfound passion for teaching and research. Ultimately, I have become very skilled at writing proposals, generating external funding, and mentoring numerous students in my research lab. The end result is that I was promoted to Associate Professor and awarded tenure in Spring 2015. All of these achievements would not have been possible without the foundation provided to me by QEM, its affiliates, and mentors. Notably, the two areas that I found to be the most beneficial were the preparation/submission of research proposals and the integration of research and education. The influences of these areas on my growth and productivity over the past several years are further discussed below.

1.1 Emphasis on Research Proposal Preparation/Submission

My first encounter with writing a proposal occurred within my first month at Fisk University. A senior faculty member suggested that I rewrite an MRI proposal that had been submitted a year earlier but did not receive funding. As a new faculty member, this petrified me because I had never written a proposal. I attempted it anyway in an effort to please my superiors.
The outcome was horrible! The proposal was so badly written that even now I use it as a reminder of “what NOT to do” when writing proposals. Some of the immediate problems included grammatical and spelling mistakes, poor clarity of research objectives and goals, no timelines, and lack of support documents from university administrators and collaborators.

In hindsight, I should have been truthful and told my superiors that I did not understand what I was doing. Truly, I did not even realize that some of these things were necessary for the proposal until I became a member of QEM’s Faculty Professional Development and Mentoring (PDM) Program in 2010. Dr. McBay and her team brought together experts in various areas of grant writing and proposal preparation to help mold faculty and give us insight that we had not received before. In this program, I was given the tools required to navigate and become successful at preparing, writing, and submitting a proposal to the National Science Foundation. Additionally, I attended various other QEM workshops (CAREER and Chemistry) to improve my knowledge about various NSF programs for which I was interested in writing a proposal. Through my attendance and with the help and revision of my one-page summary by the consultants, I learned how I could improve my grant writing skills. I also was given inside knowledge about new solicitations previously unknown to me.

In fact, it was at an Information and Proposal Development workshop in January 2011 that I was made aware of the Research Initiation Awards (RIA) initiative that had recently been announced by NSF. After finding out about this opportunity, I got together with my Dean to express my interest in submitting a proposal. With her help and guidance, I was able to submit the proposal in April 2011. Needless to say, I received this award in 2011, but I know that it was truly the information from the QEM workshop that led me on this path of success. Notably, since becoming affiliated with QEM/PDM, I have been awarded three grants, totaling over one million dollars, from the National Science Foundation: the Faculty Early Career Development (CAREER) Award; an HBCU-UP Targeted Infusion Project (TIP); and the RIA.

The most significant lessons I learned about proposal preparation and submission during the QEM workshops were to read the solicitations, find the main points that needed to be addressed, and make sure that each focus point is included in the proposal. Over the years, I have found these points to be the key to writing and understanding the proposal preparation and submission process to NSF and other funding agencies. I truly appreciate all of the assistance (financially and professionally) because the impact on my growth and success as a professor at a HBCU has been immeasurable.

### 1.2 INTEGRATION OF RESEARCH AND EDUCATION

The incorporation of student research experiences into the regular academic-year curriculum increases student academic gains and interest in STEM careers, in part by encouraging students to think like scientists. However, early in my career, I could not determine how to integrate research and education because I felt that they were two separate entities. The QEM/PDM program gave me great insight on how I could accomplish this through mentoring and curriculum development. With the assistance from numerous consultants and mentors, I learned how to incorporate my research into my coursework as well as to develop a mentoring network between the students and me that has led to their success in the classroom.
and laboratory. Additionally, I also refined not only what I was doing in the lab but also how I was selecting the students to conduct the research by implementing mandatory volunteer research in the first year and a GPA restriction.

One of the greatest lessons that I have learned is that successful incorporation of undergraduates into any research group is based on two primary objectives:

1. allowing students to develop projects within my research scope that provide them with interesting and relevant research questions as well as opportunities to gain hands-on experience; and

2. developing a mentoring structure that offers support to the students when needed.

To accomplish the first objective, I have found that emphasizing research “early and often” in a student’s undergraduate experience has a profound effect on student learning, retention in STEM, and post-undergraduate success. The effect of this early intervention on underrepresented minorities has been demonstrated by students in various undergraduate research opportunities. Evidence from institutions that engage students in research early, like the College of Wooster, illustrates the effectiveness of implementing stage-appropriate research experiences in introductory level courses and increasing the scope and expectation of independence as the student develops. In my laboratory, I have observed that most of the students who have conducted research with me from their freshman year are typically bitten by the “research bug.” Oftentimes these students choose research as their career of choice and choose to attend graduate school or pursue MDs or PhDs.

My second objective was fulfilled by organizing my laboratory research efforts to emphasize peer mentoring by senior undergraduates and Master’s level graduate trainees. New students in the lab are paired with a respective graduate student working on a similar project and with more senior undergraduates working on some aspect of the same program. Together, these trainees work to accomplish their research project’s goals. Additionally, all new students in my lab are expected to take a polymer chemistry short course before they begin research to familiarize themselves with the basic concepts. Furthermore, through weekly group meetings, discussions, and review of pertinent journal articles or other sources of information about similar research, new trainees in the lab continually improve their laboratory skills while also developing their ability to articulate hypotheses, design experiments, analyze data, and propose next-step experiments. This process also helps students learn to communicate with each other and operate within the same research space.

**Conclusion and Perspective**

If I could use one word to describe how my involvement in the QEM/PDM program influenced my growth and development from Assistant to Associate Professor, it would be “PRICELESS.” Being a faculty member at an HBCU is a hard job, but being a member of PDM made my life bearable. The assistance and advice from the entire QEM Network staff was exactly the jump-start I needed to refuel my passion for teaching and research. This program should become a mandatory requirement for new assistant professors. Lastly, I have to say that the QEM/PDM program was a godsend for my academic career, and I will always be thankful for their presence in my life.
ENDNOTES


vi SOARS case study; Pandya, Henserson, Anthes, and Johnson 2007.

ABOUT THE AUTHOR

Natalie Arnett is an Associate Professor of Chemistry at Fisk University. In January 2015, Dr. Arnett received an NSF Faculty Early Career Development (CAREER) Program award to support her research on developing novel membrane materials for fuel cell applications and the integration of this research into polymer education through appropriate courses and laboratory experiences. Through this award, she will design the "Introduction to Polymer Chemistry: General Chemistry Concepts" lecture and lab, a new course for freshman students at Fisk.

Dr. Arnett serves as the Director of Graduate Studies in Chemistry at Fisk and has an adjunct appointment in the Department of Chemistry at Vanderbilt University. She is a member of American Chemical Society and the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE). Dr. Arnett received the B.S. degree in Chemistry from Grambling State University and the Ph.D. degree in Chemistry from Virginia Polytechnic Institute and State University.
Summary
Teacher-Scholars are actively engaged in research; remain current with the developments in their field and involve undergraduate students in their scholarship. In addition, they use effective pedagogical methods and emphasize deep learning in the classroom. In the Teacher-Scholar model, teaching and scholarship do not detract from each other but rather enhance and inform one another. In this essay, I outline the factors that enabled my development as a Teacher-Scholar and supported my productivity at Spelman College. These include the recognition by the department and the institution that conducting research is an integral part of teaching and thus given teaching credit; making explicit career advancement plans while working with a mentor; and providing a structure through a syllabus and leveraging peer-to-peer cooperation in my lab. As of summer 2015, I have mentored 32 students in my lab and provided outstanding research experiences allowing students to generate publishable data. Several of these students are now in graduate or professional schools training to become the next generation of scholars.

During my years as a junior faculty member in the Biology department at Spelman College, I was a recipient of the PDM faculty development award. The award provided significant release time and student stipends, with the ultimate goal of enhancing the research capacity, student training, and scholarly productivity of awardees. The grant aligned with my goal to fully develop as a Teacher-Scholar at Spelman, a Historically Black College for women.

The Teacher-Scholar Model
While student training and scholarly productivity might come across as separate or even antagonistic from the perspective of academic career advancement, the Teacher-Scholar model of faculty is based upon the connectedness between scholarship, teaching and even service. This idea was first articulated by Boyer (1990) and subsequently refined and reinterpreted for different institutional contexts. Teacher-Scholars are generally actively engaged in their disciplinary research, consistently integrate new knowledge into their teaching, and emphasize inquiry and deep learning, resulting in a high-quality undergraduate education (Kuh et al., 2007). Teacher-Scholars also work closely with students on research projects and allow a continuum between the academic lives and personal lives of students as mentors and role models.
It is with these parameters in mind that I approached my work with undergraduate students in my lab, as well as teaching both introductory-level and upper-level Biology courses. While I emphasize more the process of inquiry, experimental design, analysis, and interpretation in my introductory classroom, I engage students in my upper-level course with an authentic research question. Students from the course have often decided to continue and expand the project the following semester and present it during research day. Finally, with undergraduate students conducting research in my lab, the scope of the research, the depth of knowledge, the skills gained, and the sense of ownership of the project were taken to a new level. While there may not be a direct impact of my teaching on my research, it fosters the passion to learn and contribute to a research-supportive curriculum. In fact, as reported by Kuh et al., (2007) engagement in research has negative outcomes in institutions where faculty do not place much emphasis on deep learning.

Attending pedagogical workshops, in particular the weeklong National Academies Summer Institute (Pfund et al., 2009), has been valuable in bridging my teaching and research. While the workshop was originally designed to improve undergraduate education around the nation at the introductory level, the approach used can be extended to upper level courses and even undergraduate research. The workshop allowed me to be intentional and methodical in using practices that are effective to enhance deep learning. For example, I often evaluate the skills and content knowledge required to complete a complex research project or problem and ensure that students are proficient with those skills, a practice referred to as scaffolding. Returning to the workshop the following year as a facilitator was equally beneficial in engraining those practices.

“My scholarship at Spelman has been recognized on campus … nationally … and abroad …”

Factors Supporting Scholarly Productivity

In this context, where student learning outcomes and training are an important facet of research, how can we ensure that productivity is sustained? Below, I will enumerate factors that have been instrumental in ensuring that these activities resulted in scholarly productivity.

- **Institutional and Departmental Support.** In 2009, the Biology department at Spelman launched a series of undergraduate research courses (Bio487) in the specialty areas of individual faculty. This enabled faculty to offer research experiences to a maximum of 5 students enrolled in the course while getting teaching credit for it. In doing so, the department recognized the time and effort spent by faculty in doing research with undergraduates. Students also earn credit for these courses that counts toward fulfilling their requirements for the major. This mechanism significantly contributed to the increase in the number of students conducting research. The number of oral and poster presentations in Biology at the annual Research Day at Spelman increased from an average of 27 before 2009 to an average of 59 after 2009, while the number of students and faculty remained the same, demonstrating the impact of this departmental practice in bridging faculty research and instruction. In addition, the required meetings for all students taking Bio487 courses has
provided us not only a mechanism to monitor student progress in research but also a forum where we cultivate the research culture in our Department.

- **Funding.** As a junior faculty, I have been the recipient of funding from various sources (Quality Education for Minorities, Howard Hughes Medical Institute, National Science Foundation, National Institute of Health-CHDRE). The funding enabled me to obtain course releases, the necessary supplies, and a technician that could manage the day-to-day activities in the lab, all of which allowed me to tackle significant projects with my students. In addition, these funding sources allowed me and my students to attend conferences, network, and obtain feedback on our work.

- **Academic career advancement planning.** As part of the activities in the PDM program, I developed an academic career advancement plan and discussed it with my mentor. The plan was periodically revisited and updated. This activity was helpful in setting realistic goals, planning the activities to achieve those goals, setting a timeline and having a sense of accountability. It served as a constant reminder of my goals and kept me focused on my scholarly productivity.

- **Syllabus.** All students conducting research in my lab, whether they are enrolled in an undergraduate research course for credit or otherwise, receive a syllabus. The syllabus clarified expectations early on regarding lab hours, laboratory notebooks, and attendance in lab meetings and presentations. The latter includes presentations of their research or leading journal clubs. Students also take a personalized take-home exam to ensure they have background and foundational knowledge of their areas of research. A final expectation is that the research will be presented at the annual Research Day on campus. Although the syllabus emphasizes student engagement in the process of conducting research, they are better prepared to be productive as they develop the skills and area content knowledge. Whenever support is available, students also are encouraged to participate in regional or national meetings to present their findings.

- **Peer Cooperation.** Whenever possible during a given semester, I plan similar experiments for all students in the lab in order to leverage peer-to-peer cooperation. This results in students helping one another in the acquisition of new skills, solidifying newly-gained skills, sharing resources, and discussing their experiments. Previous examples of how I leveraged peer-to-peer cooperation include semesters in which all students conducted yeast two-hybrid experiments, but with different baits, or semesters where students conducted plant transformation experiments, but with different constructs, etc. This has not only resulted in my presence being less critical at all times in the lab, but also provided students the opportunity to become active participants in the learning process, increase their self-efficacy, and take ownership of their projects.

- **Collaborations.** I had the opportunity to spend 10 weeks during the summer of 2011 as a visiting faculty in David Bartel’s lab at the Massachusetts Institute of Technology. This allowed me to conduct the technically challenging procedures for the preparation of transcriptome and translatome libraries in a lab where appropriate expertise and resources were available. In addition, it provided me access to the sequencing facilities of MIT. The novel insights on plant responses to antibiotics gained from this work were eventually published in PLOS One (Mentewab et al., 2014).
Conclusion and Perspective

The largest contingent of African-Americans who obtained Ph.D.s in STEM fields completed their undergraduate degrees at Historically Black Colleges and Universities (HBCUs). According to NSF, Spelman ranks 2nd among all institutions as the bachelor’s degree-granting institution of African Americans who have obtained doctorate degrees in STEM fields (Fiegener and Proudfoot, 2013). The success of Spelman and HBCUs is based on providing an environment that fosters the intellectual and personal development of their students. Faculty are an essential component of this environment and their own development as Teacher-Scholars is central to the impact they will have on students. Several factors, from the level of the institution and department to my approaches in the classroom or lab, have been instrumental in fostering my own development as a Teacher-Scholar and ensuring my scholarly productivity.

During my years as a junior faculty, I established a track record of independent and innovative research by being the first and corresponding author on all three peer-reviewed publications generated at Spelman, and PI on all four significant grants obtained. Thus far, my scholarship at Spelman has been recognized on campus with the Presidential Award for Excellence in Research, nationally with the participation in a white paper to NSF and reviewing opportunities at the agency, and abroad with invitations to give oral presentations in Spain and the Czech Republic. Finally, my work at Spelman has a strong emphasis on student-focused research that provides outstanding research experiences, allowing students to generate publishable data, win at Research Day for their presentations, and pursue graduate studies. Now that I have been tenured and promoted to the rank of Associate Professor, I intend to remain a Teacher-Scholar at the forefront of educating the latest generation of talented African-American women who continue their education in graduate and professional schools.

REFERENCES


ABOUT THE AUTHOR

Mentewab Ayalew is Associate Professor in the Department of Biology at Spelman College. She also serves as co-director of the Biomedical Scholars Living and Learning Community Program. Dr. Ayalew’s research focuses on understanding the mechanisms of antibiotic resistance associated with the *Arabidopsis thaliana* ABC transporter. Her research activities are funded through grants from the National Science Foundation and Proctor & Gamble. She received the Presidential Award for Excellence in Research from Spelman College in 2012.

Dr. Ayalew has over 20 publications in refereed journals and is an ad-hoc reviewer for two journals: *Heredity* and the *Journal of Veterinary Science*. She is a member of the Council for Undergraduate Research, the American Association for the Advancement of Science, and the American Society of Plant Biologists. Dr. Ayalew received the B.S. degree in Biotechnology, and the M.S. and Ph.D. degrees in Plant Cellular and Molecular Biology from the Institut National Polytechnique, Ecole Nationale Supérieure d’Agronomie de Toulouse, France.
The Quality Education for Minorities (QEM)
Network’s Map for Success in Research Development and Funding Acquisition:
Excellent Proposal Writing Skills and In-Depth Exposure to Funding Agency Subculture

Max Winshell A. Fontus
Undergraduate Medical Academy
Prairie View A&M University
Prairie View, TX 77446

Summary

In 2010, I was selected to participate in the Quality Education for Minorities (QEM) Professional Development and Mentoring (PDM) program. The PDM program was a key component of QEM’s Education Research project supported by the National Science Foundation (NSF)’s Historically Black Colleges and Universities Undergraduate Program (HBCU-UP). The aim of the project was to determine conditions contributing to the success of early career STEM faculty in obtaining external support to conduct major research (QEM web1). The following features of the project were implemented and their effects on the productivity and ability of these STEM faculty members to secure funding from external funding agencies were assessed. These features include:

1) Funding for involvement of undergraduate research assistants for participating faculty
2) Guidance from senior faculty research mentors
3) A peer network and support community
4) Emphasis on research proposal preparation/submission
5) Planning and pursuing a research agenda
6) Academic career advancement planning
7) Integration of research and education (e.g., mentoring undergraduates and curriculum development)
8) Coaching on scientific presentation skills
9) In-depth exposure to NSF processes, practices, and personnel.

During the course of the PDM program, QEM provided release time for participants as well as support for undergraduate researchers in order to help accomplish the project’s goals of research productivity and success in securing external funding support. In addition, there were specific features designed and implemented to ensure the success of the participants. I will focus on two of these features: emphasis on research proposal preparation/submission and in-depth exposure to NSF processes, practices, and personnel.
RESEARCH PROPOSAL PREPARATION/SUBMISSION

QEM organized proposal preparation/submission workshops with HBCU faculty members in mind (2). The aim was to increase the likelihood of participants being funded by writing competitive proposals. A crucial part of these workshops centered on familiarity with the NSF submission mechanism and the writing process. The former included everything from NSF’s criteria for funding (i.e., intellectual merit and broader impacts) and the different sections that a proposal must contain and what those sections must address to the length, margins, and font style of the proposal. The workshops stressed the need for a coherent proposal, with consultants advising on matters such as how the budget section must match the level of proposed activity. QEM staff emphasized that the proposal must be written as if you already have the grant and you are ready to commence the work.

In addition, QEM zeroed in on the fact that it is not enough to know how to write but how to write to address the particular NSF directorate’s needs. QEM invited program directors to discuss what they were looking for in particular program solicitations. Proposal writers were encouraged to thoroughly read solicitations and to pay attention to goals and objectives of the program so that the proposal could be aligned with the directorate’s mission. Additionally, QEM arranged for directors to review the project summaries of participants’ proposals to determine whether the proposed ideas were appropriate for submission to that directorate and were competitive. PDM participants got to meet the program directors and, in turn, directors got to put faces to names. Professional connections were made that have continued, a priceless outcome of the QEM sessions.

Another outcome of the workshops was the creation of a culture of success. When more HBCU professors secure grants, the awareness effect works in two ways: the funding agency becomes more aware of the ability of our institutions to write well-crafted proposals and produce results, but more importantly, other faculty members at our institutions become aware of available funding opportunities and can confidently seek them out.

EXPOSURE TO NSF PROCESSES, PRACTICES, AND PERSONNEL

Another facet of QEM’s project that I found really impactful was in-depth exposure PDM participants gained to NSF processes, practices and personnel. The result of this exposure was acclimation to NSF culture. NSF runs like a well-oiled machine, with intricate processes and mechanisms. By becoming familiar with the power structure and the functional structure at NSF, the participants now know what to expect at every stage of the evaluation process and are ready to address expected and possibly unexpected inquiries from the different levels of the organization. This readiness in turn highlights the ability of the principal investigator to successfully deliver on the promised product or products.

Another benefit of this comprehensive exposure is the opportunity for the participants to serve as panel reviewers for NSF. I had the chance to serve on a review panel, and it has been an invaluable experience. Far from just being a résumé builder, this experience offers the participant...
an insider’s perspective on the proposal evaluation process. Reviewers get to see what is considered a bad, a good, and a great proposal. Serving on a review panel reinforced the principles learned in the QEM proposal writing workshops and the necessity to adhere to them in order to achieve success.

Moreover, this activity expanded the participants’ professional network as they developed formal and informal relationships with the different reviewers, the program director, and the NSF staff. Lastly, indicating interest in serving as a panel reviewer can indicate to other participants the level of perceived success in seeking funding, especially as demands for the reviewer’s service increase.

There is a saying by Jack Heath: “Better the devil you know than the one you don’t” (3). Unfortunately, when it comes to proposal review and funding, NSF, as an organization, is not immune to this principle. Once you get a proposal funded, it is easier to get another one funded. I can venture a guess that a current or previous principal investigator is far more likely to receive additional awards than an individual submitting a proposal for the first time. The QEM PDM activities have definitely tipped the scale and reshaped the discussion as it relates to the capacity of HBCU faculty to consistently secure grants from NSF (4). What QEM has effectively done is change the paternalistic dynamics that have existed for too long between funding agencies like NSF and HBCUs. According to this dynamic, many HBCUs were relegated to mostly partner institution roles and not leading institutions on most proposals.

QEM has identified factors that can be used to render our HBCUs more competitive to funding agencies and bolster the claim that they, too, can be leading institutions on major grants. In times of economic hardship, when the very existence and necessity of institutions like HBCUs are being called into question, QEM has identified local factors that administrators need to pay attention to professionally develop their professoriate, turn them into well-established proposal writers and respected researchers, strengthen their research agendas and reinforce infrastructures, and secure a niche in academe in which questions about necessity would become moot. Given the success of the PDM participants, it is hard to argue against this finding (4). In 2014, QEM organized a meeting involving administrators and their PDM participant faculty members to discuss sustainability and implementation plans for strategies that the program has shown to be essential for success in the present funding landscape. What QEM has essentially and forcefully substantiated is a blueprint for successfully securing external support for any and every minority serving institution.
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ABOUT THE AUTHOR

Max Fontus is Assistant Professor of Chemistry in the Undergraduate Medical Academy at Prairie View A&M University, in Texas. Dr. Fontus’ research focuses on the application of physico-chemical laws in order to understand the evolution of a particular system of interest. He has authored/co-authored articles in professional journals as well as published an E-book on General Chemistry, in 2015.

Dr. Fontus received the Faculty Senate Award in 2013. He is a member of the Pharmaceutical Review Journal, the American Chemical Society (ACS), and the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE). Dr. Fontus received the B.S. degree in Mathematics from Pennsylvania State University, and the M.A. degree in Mathematics and Ph.D. degree in Theoretical Physical Chemistry from Indiana University Bloomington.
My Experience as a PDM Fellow

Triscia W. Hendrickson
Department of Biology
Morehouse College
Atlanta, GA 30317

Summary

In December of 2010, I was awarded a Professional Development and Mentoring (PDM) Fellowship by the Quality Education for Minorities (QEM) Network. The Fellowship began May 2011 and ended September 2013. The objective of the PDM program was to provide professional development and mentoring for junior Science, Technology, Engineering and Mathematics (STEM) faculty at Historically Black Colleges and Universities (HBCUs) that would enable the participating faculty to successfully apply for federal research grants and train undergraduate students.

My career at Morehouse College began in the fall of 2004 with an appointment in the Biology Department as a tenure-track assistant professor. My start-up package at Morehouse College included one year of release time (50%). During my second year at Morehouse I took a medical leave of absence, which resulted in the adjustment of my tenure clock. The tenure rules at the time allowed one to apply for tenure between the 6th and 9th year of appointment. Upon my return from medical leave in 2006, I reestablished my research program and successfully applied for an MBRS-SCORE grant, awarded by the National Institute of General Medical Sciences of the National Institutes of Health.

The MBRS-SCORE grant provided four years of funding (2007-2011), during which time I produced two manuscripts, trained several undergraduate students, hired one lab technician and significantly contributed to the research infrastructure at the college. In addition to funding for supplies and equipment, the SCORE grant provided 25% release time to conduct research; however, this did not sufficiently reduce my teaching load, such that I could be fully engaged in my research.

The PDM fellowship, which began just as my SCORE grant concluded, provided 50% release time, which allowed me to complete the work needed to publish two peer-reviewed articles while training undergraduate students.
RESEARCH

During the PDM fellowship, my research was focused on understanding the mechanisms that regulate the assembly and activity of one type of molecular motors, the axonemal dyneins. Dyneins are minus-end directed microtubule motors that are involved in transporting various cellular cargoes [1]. There are two classes of dyneins: cytoplasmic and axonemal. The axonemal dyneins, which are found in cilia and flagella, are further subdivided into two categories based on their location on the microtubule doublets: outer dynein arms and inner dynein arms. Studies have shown that the outer dynein arms are responsible for the beat frequency and the power required for ciliary motility, while the inner dynein arms regulate the size and shape of the ciliary bend [2]. While much is known about the assembly and regulation of the outer dynein arms, we are just now beginning to understand how the inner arms are assembled and regulated. Of the six different species of inner arms, the inner arm complex I1 (also known as the f-dynein) is the most characterized; it is comprised of 10 dynein subunits, including three intermediate chains: IC140, IC138, and IC97 [3]. Studies have shown that mutations in these intermediate chains lead to defects in motility [4,5,6].

The PDM-funded project focused on elucidating the roles of IC138 and IC140 in the assembly and regulation of the I1 dynein complex. Specific aims during the PDM funding period:

1. **Determine the tubulin-binding site on IC138 and IC140.** IC140 is essential for the assembly of I1; however, the associations between the components of the complex are not clearly understood [7]. While, it is known that the I1 complex binds to the microtubule doublet at discrete locations along the axoneme, the exact nature of the interaction between the I1 complex and the microtubule doublet remained unknown, until my recent work indicated a direct association between the intermediate chain dyneins and tubulin [8]. Further characterization of these interactions will provide us with a better understanding of how molecular motors interact with their cargoes.

2. **Determine the key phosphor-residues on IC138.** IC138 is the key regulatory subunit in the I1 complex. Previous studies have shown that phosphorylation of IC138 results in the dynein being inactive. Identifying the key phosphorylation sites on IC138 will allow us to better understand how the dynein is regulated.

3. **Determine whether calcium affects the phosphorylation state of IC138 and thus the activity of I1.** The kinases and phosphatases that act on IC138 are associated with the radial spokes. Previous studies have shown that the radial spokes and central pair apparatus are key components of a calcium-signaling pathway that regulates dynein activity. Therefore, we hypothesize that IC138 phosphorylation may be regulated by calcium.

4. **Identify pf4 suppressors that are novel interactions of I1.** The pf4 gene in *Chlamydomonas reinhardtii* encodes a subunit of the PP2A phosphatase that is involved in the regulation of IC138 [9]. Genetic suppressors of pf4 have been isolated and many exhibit phenotypes similar to those of I1 mutants. These suppressors will be characterized to identify novel proteins that interact with the I1 dynein complex.
During the funding period, aims 1 and 3 were completed and the results published:


Unfortunately, another research group published a study detailing the phosphor-residues of IC138. Specific aim 4 is an ongoing project in collaboration with another research group. The release time, funded by the PDM fellowship, was a major contributing factor in the completion of these studies. Additionally, there was another PDM fellow in my department who also had 50% release time. This provided sufficient funding for the department to hire a well-qualified full-time instructor to teach our courses. This was the first time in recent history that the department was able to capitalize on the funding brought in by its faculty members. Previously, the College would only allow departments to hire adjuncts at a rate of $2500/course, a practice that greatly reduced the chances of attracting highly qualified part-time instructors. At the insistence of the President of QEM, the College allowed the department to use all of the release time funds to hire a well-qualified replacement. As a result of this, there is now precedent at the College of allowing departments to utilize all of the release-time funds brought in by faculty members; moreover, the Office of Academic Affairs is willing to work with departments on ensuring that release time funds are used effectively.

“Overall, the PDM fellowship proved to be extremely beneficial, as it provided me with a significant amount of release time, which resulted in two peer-reviewed publications.”

**MENTORING**

During the fellowship period, I was mentored by a senior faculty member from another institution while also mentoring several undergraduate students. Morehouse College is a Liberal Arts institution that prides itself on offering research training opportunities to its students. Many of the Biology majors at Morehouse College are interested in professional health careers or in attaining a Ph.D. In order to be successful when applying to graduate or professional school, it is imperative that students have some research experience as it serves to develop their critical thinking, analytical, and communication skills. During my career at Morehouse College I have trained over 20 Atlanta University Center students in my lab, two of whom were funded by the PDM fellowship. One of the PDM-funded students is the first author on a peer-reviewed publication that summarized the effect of calcium on flagellar motility [10]. Both PDM-funded students presented their work at local and national conferences, including the Annual Meeting of the American Society for Cell Biology.
PROFESSIONAL DEVELOPMENT

The program organized several professional development workshops that focused primarily on grant writing. The expectation was that each fellow would submit a research proposal to the National Science Foundation. At the conclusion of the fellowship, I submitted a collaborative proposal to the NSF; unfortunately the proposal was not funded. However, I have since received NSF funding for a training grant. Additionally, I am the Principal Investigator (PI) and Director of the MARC-U*STAR program at Morehouse College.

Overall, the PDM fellowship proved to be extremely beneficial, as it provided me with a significant amount of release time, which resulted in two peer-reviewed publications. The program also offered me the opportunity to further develop my mentoring skills while also being mentored, skills that I utilize in my leadership roles in the MARC/U*STAR and Robert Noyce Pre-Service STEM Teacher Training Programs. Moreover, as a result of PDM support, I was successful in my application for tenure in the fall of 2013.

REFERENCES

ABOUT THE AUTHOR

Triscia Hendrickson is Associate Professor in the Department of Biology at Morehouse College, in Atlanta, GA. Dr. Hendrickson’s research focuses on understanding the biological processes involved in controlling the activity of the minus-end microtubule directed motor dynein. She is an author/co-author of more than 5 peer-reviewed articles and serves as the Principal Investigator and Director of the National Institute of General Medical Sciences-Minority Access to Research Careers/Undergraduate Student Training in Academic Research Program (NIGMS-MARC/U*STAR) at Morehouse. The NIGMS-MARC/U*STAR Program is an honors research training program that provides juniors and seniors with advanced research training opportunities.

Dr. Hendrickson is a member of the American Society for Cell Biology (ASCB) and has served on several ASCB committees, including Women in Cell Biology, Minority Affairs, and the Teaching in Africa Initiative. Dr. Hendrickson received the B.S. degree in Biology from University of Virgin Islands and the Ph.D. degree in Biochemistry, Cell & Developmental Biology from Emory University.
Involvement of, and Funding for,
Undergraduate Research Assistants in Research

Conrad W. Ingram
Department of Chemistry
Clark Atlanta University
Atlanta, GA 30314

Summary

The involvement of undergraduates as research assistants can be very beneficial to early career faculty and to all constituents, if conducted effectively. These research assistants can make significant research contributions as the faculty seeks to advance his or her discovery of new knowledge, which can lead to peer reviewed scientific publications that is often a requirement for promotion and tenure. In return students will develop research, critical thinking, and written and oral communication skills, among other benefits.

Undergraduate research has a profound impact on students’ trajectory for a future career in STEM. This engagement, however, requires strong institutional and departmental commitment of release time for early career faculty to provide training, guidance and mentoring, and also institutional commitment to provide funding for students, which in most cases is a strong necessity. Incentives should be in place, in the form of reasonable rewards for this activity during the promotion and tenure process, irrespective of whether or not manuscript(s) are published within the duration of the activity.

Undergraduate research should be judiciously planned such that it does not prove to be a hindrance, but instead facilitates progress. Students are accessed mainly by being paid a stipend, registering for research credit-hour courses, and volunteering their time in order to be engaged in research experiences for intellectual curiosity and/or to strengthen a résumé in preparation for postgraduate studies. Faculty also may integrate research and teaching for an entire class. The involvement of undergraduates as research assistants can pave the way for faculty to take risks in conducting transformative science, and this needs to be encouraged.

As a recent participant in the QEM Professional Development and Mentoring (PDM) program, I found the following areas of provided support to be extremely effective in facilitating my advancement as an early career faculty: support for undergraduate research assistants; guidance in preparing/mentoring students as research assistants; senior faculty research mentors; extensive professional development experiences; and training in research proposal preparation.
In this article, I provide my perspective on the involvement of, and funding for, undergraduate research assistants in research.

The success of early career STEM faculty at HBCUs in building their research and teaching capacity in their department, school, and university is hinged on many factors. Primary among these are the involvement of undergraduate students in their research activities and significant release time to focus strictly on proposal development, laboratory research activity, writing publications, and proactive engagement in developing the research skills of research personnel (i.e., postdocs, graduate and undergraduate students). The early career tenure-track faculty is faced with the task of being productive in the areas of teaching, research, and service. The degree to which each of these is weighted with respect to promotion and tenure varies among HBCUs and among their STEM departments.

Generally, research-intensive institutions place more emphasis on research productivity, while the more liberal arts-based institutions seem to emphasize teaching. Whereas it is obvious in the case of the former that research output is highly emphasized, the balance between teaching and research is often not clear in the case of the latter. Research-intensive majority institutions seem to emphasize that early career faculty be allowed release time equivalent to eighty percent of their time for research, with the remaining twenty percent spent on teaching and service. This is certainly not the case at most HBCUs. At my doctoral-granting institution, research output is considered a significant component of the promotion and tenure process, yet heavy course loads significantly impeded my research productivity. As a PDM program participant, I was funded for fifty percent release time to focus on research. My university’s administration, dean and department chair were required by QEM to commit to honoring this as an institutional obligation.

“The involvement of undergraduates, if done effectively, can be of tremendous benefits to all parties: the students; the faculty member; the department; and the institution. The students can provide energy, motivation, and enthusiasm to all.”

With a reduction in teaching course load to a maximum of two classes per semester, I was afforded a tremendous opportunity that was dedicated to conducting laboratory research, guiding undergraduate research assistants and other research laboratory personnel, writing grant proposals (of which two were funded), and publishing eleven peer-reviewed articles (senior author of seven and co-author of four). For one of these manuscripts, the data was acquired more than a one year prior, but little or no time was available for writing during that period. Without the release time, these accomplishments would have been extremely difficult to achieve.

Certainly, up to the third year of early career faculty members at HBCUs, research funding from successful grant proposals is often non-existent, hence financial support for students is generally not available. The challenge becomes: How will the faculty member find the personnel to conduct research? Undergraduate STEM majors are great resources, but are often overlooked. The involvement of undergraduates should by no means be viewed as a source of cheap labor for faculty, but instead should be an integral component of the institutions’ intra-
curriculum and/or co-curriculum STEM activities. Goyle purports that, “undergraduate research mentoring may be viewed as the purest form of teaching.” The involvement of undergraduates, if done effectively, can be of tremendous benefits to all parties: the students; the faculty member; the department; and the institution. The students can provide energy, motivation, and enthusiasm to all. They are extremely effective in sharing their research knowledge and experiences with their peers, thereby building, strengthening, and promulgating the STEM culture across campus. In comparison to graduate students, they are certainly a more effective group with whom to begin to cultivate the next generation of scientists. The tremendously positive impact of undergraduate students’ engagement in research towards increasing the number who earn doctorates in STEM fields, and who go on to become successful scientists, is well documented. ii

Despite the involvement of undergraduate research assistants by several early career faculty, there remain some serious concerns with respect to their impact on professional advancement in general, and promotion and tenure in particular. In many cases, it is perceived that undergraduate research is of significant benefit to the faculty member only if high quality peer-reviewed research publications result. Mentoring is considered to be in the service category, which typically accounts for only about fifteen to twenty percent of one’s performance evaluation. Consider an early career tenure track assistant professor for whom research productivity is important. The faculty member is often reluctant to invest the time and effort in grooming undergraduates to be engaged in scientific research, as he or she may perceive this as a hindrance to progress.

Working with undergraduates is often perceived as a form of teaching that slows research productivity. The quality and rigor of research output from the faculty member’s laboratory may raise some concerns, given the use of undergraduates. The faculty member may consider that the “all-important” publications can be more easily accomplished by postdocs and graduate students, if available; hence, the incentive to use undergraduates is simply absent. HBCUs must therefore begin to provide early career faculty with incentives to engage undergraduates. Incentives should be in the form of reduction in teaching course load. Incentives awarded as points that are comparable to those for publications should also be allocated for this activity in the research category, or comparable to those awarded for teaching a course in the teaching category, whether or not publications result at the time. Publications often come later in many cases, after the students graduate.

Undergraduates are generally accessed through the following means: they are paid a stipend for up to fifteen or twenty hours per week of research activity; junior and senior STEM majors can usually register for a 1-3 credit-hour course in undergraduate research; students may independently volunteer their time in order to be engaged in research experiences for their intellectual curiosity and/or to strengthen their résumés in preparation for postgraduate studies; or a faculty member can integrate research and teaching, involving an entire class in research in the form of group projects. The majority of students I have encountered fit both the first and third categories, i.e., both needing a stipend and genuinely interested in gaining or strengthening their research experiences. Here again, early career faculty are challenged with finding funds to pay stipends. It is therefore incumbent upon an institutions’ administration to provide stable sources of start-up funding to replace or sustain the unstable extramural grants that often fund innovative research and education. Both release time for faculty and the engagement of undergraduates
needs the blessing of the chair and higher administration as much as possible. This paves the way for faculty to take the risk of being engaged in transformative science, and this needs to be encouraged.

With regard to the integration of research and teaching, one recommendation is that it should be focused on problem-centered, interdisciplinary, collaborative science. Lopatto suggested that students, especially in the first year, work in teams, probably co-mentored by several faculty or other experts who gather as a team to solve a problem. This provides an enriched environment for the cross-fertilization of ideas among the students, and for them to be catalysts in creating new network of collaborators. This could also facilitate increased collaboration among the early career faculty members and their peers across departments and across disciplines, and provide an avenue for faculty members to develop a new, or become the lead of an existing, scientific network. The problem-centered research is purported to “bind together the disparate elements to create a sense of wholeness,” and therefore solve the teaching-versus-research dichotomy.

During my early career years, tens of students conducted research in my laboratory under my guidance. Many have since then matriculated in graduate schools and several have earned Ph.D.s in STEM fields. However, I wish to highlight the impact of three of my recent chemistry majors, who spent their junior and senior years in my laboratory, two of whose stipends were partly supported by QEM under the PDM program. I invited these individuals (who were students in both my instrumental methods and inorganic chemistry classes) to become research assistants in my laboratory. Assisted by my then graduate researcher, the students progressively developed the skills, attitude and focus for research, by observing his activities and approaches. I placed the first two students on two complimentary projects and they conducted exhaustive high quality research while investing their own ideas along the way.

"With regard to the integration of research and teaching, one recommendation is that it should be focused on problem-centered, interdisciplinary, collaborative science.”

In the latter part of the semester, a third student expressed interest in pursuing research in my laboratory after he became enthused and motivated by some research results that the others and I shared in the classroom. I offered him the opportunity to explore the research from another perspective. He, too, conducted meticulous research of quality that was on par with my graduate students. His notebook was detailed and very easy to follow in his absence; his thoughts and rationale for conducting each experiment were well-documented. He was able to synthesize some very unique and novel inorganic structures, in an area where my fellow researchers in the international arena were unsuccessful. A manuscript was written with all three students as co-authors, and was published as the featured cover article in the August 2015 issue of a Royal Society of Chemistry’s peer-reviewed high impact factor journal. The third student leveraged this success to now be enrolled in a Ph.D. program in inorganic chemistry at a major research university. Therefore, the engagement of undergraduates in research can be very beneficial to early career faculty and all constituents, if done effectively.
ENDNOTES


ABOUT THE AUTHOR

Conrad Ingram is a tenured Associate Professor of Chemistry at Clark Atlanta University. Dr. Ingram serves as instructor for general chemistry, inorganic chemistry, analytical chemistry (Instrumental methods), and special topics in chemistry. He has been with the chemistry department at CAU for over 21 years, moving through the ranks as a research associate, research scientist, assistant professor, and currently, associate professor of chemistry. Dr. Ingram has served as principal investigator (PI), co-PI, and senior personnel continuously, on over 27 research grants, and major research instrumentation grants to CAU amounting to over 25 million dollars ($25M). He has several publications in peer-reviewed journals, the latest of which was the cover-featured article in the August 2015 issue of CrystEngCommun.

Dr. Ingram's research focuses on the synthesis, characterization of inorganic and organic/inorganic hybrid nanophase materials for applications as catalysts, adsorbents, and fluorescence-based or magnetic-based sensors. He serves as the director the Georgia-Alabama Louis Stokes Alliance for Minority Participation (GA-AL LSAMP), an NSF-funded program that provides hands-on research and mentoring opportunities for undergraduate STEM majors at nine colleges, with Clark Atlanta University as the lead institution. Dr. Ingram received the B.S. and Ph.D. degrees in Chemistry from University of the West Indies, with aspects of his graduate studies conducted at the University of Salford in the United Kingdom.
Involvement of Undergraduate Research Assistants at a Liberal Arts Institution

Alexandra Peister
Department of Biology
Morehouse College
Atlanta, GA 30314

Summary

Research during undergraduate education has been shown to increase a student’s success and future career aspirations. Unfortunately, at most liberal arts colleges, it is not feasible to include all undergraduate students in the research labs of faculty. Typically, there are too few active research labs and limited funds available for independent research. Therefore, alternative strategies are examined that will allow a research experience for the student while benefiting the productivity of the researcher.

Although often a necessity for tenure, research at a teaching-intensive institution can have multiple challenges, including finding time, identifying research students, and funding. Several of these issues can be addressed by utilizing students taking research-for-credit courses or those who are taking summer classes. Many research projects can be broken into small, manageable subprojects that students in a laboratory course could pursue. Funding research in a laboratory class setting is often possible through the lab fees, and having multiple hands to help optimize protocols is quite beneficial. Major lab equipment can be procured from nearby research institutions when they are upgrading their systems. Persistence and creativity in research at a liberal arts institution can produce high-quality, publishable research that benefits both the faculty and students.

The QEM Professional Development and Mentoring (PDM) program provided my students and me an enhanced educational and research experience and was of great benefit particularly in engaging undergraduate students in my research.

Research experience during the undergraduate years is a driving factor for students’ likelihood to pursue graduate degrees. Studies have shown that approximately 80 percent of students with a research experience go on to pursue graduate degrees, compared to approximately 60 percent of students without research experience (Bauer, 2003; Hathaway, 2002). Unfortunately, at most institutions, it is unlikely that the majority of the students will have this experience. There are too many students and not enough research labs.
Most student research experiences are based on the apprenticeship model, where a limited number of students conduct research in a faculty member’s laboratory (Wei, 2011). This is a well-established method of providing a research experience and is of great benefit to the student. However, intense training demands limit the number of students who receive this experience, as well as limit progress to the research by the faculty due to the constant training cycle of new students. In larger institutions that have graduate students, this creates less of a strain on the faculty member, but the overwhelming number of students makes it challenging to involve them in authentic research.

Utilizing undergraduate research assistants can benefit both the students and researchers (Lopatto, 2010; Advisory Council, 2012). There are several methods for making student apprenticeship-type research experiences feasible in an undergraduate institution. Discussed below will be the benefits of undergraduate research during the summer session, credit-based research experiences, and the utilization of work-study funds. Summer is when many faculty have the time to dedicate to their research interests. Students that are taking a summer course can often be persuaded to spend significant time in the lab. The students are already on campus, with room and board covered, so they are often more flexible in their funding needs. Students in the sciences are highly encouraged to seek full time summer research programs. But students who are unable to participate in these full time programs due to their courses can receive valuable experience from the part-time summer research. If the project is developed correctly, this can be a benefit to both the student and the researcher.

“Discussed below will be the benefits of undergraduate research during the summer session, credit-based research experiences, and the utilization of work-study funds.”

Although the students will have more time during the summer, the weeks they are on campus are also limited. Therefore, several considerations must be made for their research projects to produce the most benefit to both the student and the faculty. Since summer is the most productive time for research at undergraduate institutions, it is vital that the faculty have time to make progress on the work, not just train the students. The students need projects with techniques they can learn quickly, and carry out with minimal supervision once trained. If the experiment is too complex, the faculty will spend the summer training the students without significant data collection.

Ideally, if more than one student is in the lab for the summer, they should have related projects so they can be trained together and can help each other when questions arise. When I have techniques that will take significant time to master, such as tissue culture, the students will have this as a side project and the main project will be one that they can master quickly and produce data before the summer ends. Ideally, the students will continue in the lab past the summer and can use the complex techniques for which they are already trained.

This leads into the use of undergraduate students for mentored research during the academic year. Many institutions have research programs on campus that require a student to conduct a significant number of hours in the lab, such as MBRS-Rise and Marc U*STAR. These
students are typically motivated, often have prior research experience, and often make great
additions to the research lab.

If the students are not in a research program through campus, it is often possible for the
students to take an independent research course. This can often benefit the faculty member as
well, as some institutions give teaching credit or release time to compensate for this time.
Additionally, since the student is paying for the credit, the institution may allow limited supply
funds to cover the cost. It should be noted that most programs and institutions prohibit the
students from receiving scholarships or stipends through a research program such as those
described above and taking a courses for credit, but the students can decide which is more
advantageous to them.

If available, students can also be paid either through federal work-study funds or through
the researcher’s grants. Because of the time required for training a student, it is not uncommon to
require the students to volunteer for a semester prior to providing funds. Typically this semester
focuses on learning techniques and rarely produces usable data for the lab. Requiring the
students initially to volunteer their time demonstrates commitment by the students that they
really want to perform the research. It also allows evaluation of the student’s aptitude and
interest prior to using scarce funds. Utilizing upperclassmen to train the underclassmen can
decrease the training time from the faculty. This also creates a continuum of knowledge for
research techniques.

“… research has shown that course-based research experiences
(CUREs) can be of significant value to student development.”

In addition to the apprentice-type experiences, research has shown that course-based
research experiences (CUREs) can be of significant value to student development (Auchincloss,
2014; Corwin, 2015; Wei, 2011). These CUREs can be very beneficial to the researchers too.
The CUREs are typically a semester-long project and can be developed around faculty’s own
research interests. Projects must be carefully structured to allow students to have ownership
of their piece of the project, while having it relate to the data collected by the other students.
Ownership of the project is key to a CURE success. Each student/group must have a clear
explanation of their part of the project and it should be stressed that without their part, the
research will not be published.

These projects can be highly beneficial if they involve tasks such as testing multiple
conditions around a common theme. Each student or group has their own project, but they are all
related. The projects need to be similar or it is overwhelming to plan for multiple, unrelated
experiments. Student ownership of the project has been shown to increase the effect of the
CURE for the students (Shaffer, 2013; Hanauer, 2006; Schaffer, 2010). This means the students
should be required to determine the items needed for the next class, as well as take part in the
prep work and clean up. This is a real part of research and teaches the students to be conscious of
the materials they are using. In a research lab, no one is going to make the buffer for them and
aliquot reagents into single-use tubes. Make them responsible for stocking their benches with
supplies and have consequences if the research area is not left tidy.
CUREs can also help with the cost of the research. If the research is done during a lab, typically lab fees or departmental budgets will cover the cost of the supplies. As a bonus, left over class supplies can often be used for additional research. Suppliers are sometimes willing to give samples or even full-size supplies to teaching labs. It makes financial sense to companies because it taps into a new generation of researchers.

Equipment is often a barrier due to the high up-front cost. Older, but perfectly functional, lab equipment can sometimes be on indefinite loan from larger institutions. For example, a nearby university lab was upgrading their microscope to one that had an automated stage. The old one was completely functional and we were able to fill out paperwork to get the microscope ‘on loan’ from the university. Biotech companies may donate equipment to a school so they can receive a tax write-off; this is how we procured our DNA microarray equipment. Through creative procurement, it is possible to obtain the necessary supplies to produce high-quality, publishable research with undergraduate research assistants.

I was fortunate to be a part of QEM’s HBCU-UP Faculty Professional Development and Mentoring (PDM) Program, which provided many of the above-mentioned opportunities. The PDM program provided course release time so I could spend more time conducting research. This allowed me to bring additional students into the lab to increase the productivity of the lab. Additionally, the PDM project provided research stipends for students to work during the summer, which enhanced the research output. Finally, the PDM program introduced me to many other researchers at HBCUs. This allowed me to gain insight into the use of course laboratory research to bring additional students into the research and increase overall productivity while producing an authentic research experience for the students. Overall, the QEM PDM program allowed for an enhanced educational and research experience and was of great benefit to both my students and me.

LITERATURE CITED

ABOUT THE AUTHOR

Alexandra Peister is Associate Professor of Biology at Morehouse College. Dr. Peister’s research focuses on characterizing and quantifying the relative regenerative capacities of stem cells isolated from five distinct stages of human development (embryonic, fetal, adult, tissue-specific adult, and induced pluripotent) and assessment of the effectiveness of different stem cells for tissue regeneration. Her research activities are funded through a grant from the National Science Foundation. Dr. Peister received the Outstanding Research Mentor of the Year Award from Morehouse College’s Dr. John H. Hopps, Jr. Defense Research Scholars Program in 2014.

Dr. Peister professional service includes membership in the International Society for Stem Cell Research and the International Society for Cellular Therapy, and on Morehouse College’s Institutional Review Board. She has over 18 publications in refereed journals. Dr. Peister received the B.S. degree in Biology from Franklin and Marshall College and the Ph.D. degree in Human Genetics and Stem Cells from Tulane University.
Improving Proposal Development Skills through Workshops and Senior Faculty Mentoring

Lei Qian
Department of Mathematics and Computer Science
Fisk University
Nashville, TN

Summary
In 2010, I was selected as a participant in the QEM PDM program. The program provided me tremendous support with proposal development, research support and senior faculty mentoring. Since participating in the PDM program, I have developed six proposals as PI or co-PI. One proposal was funded by the National Institutes of Health (NIH), for which I am the PI; one proposal was funded by the National Science Foundation (NSF), for which I am a Co-PI; and one proposal was funded by Hewlett Packard, for which I serve as PI. This success indicates the effectiveness of workshops and senior mentoring for the improvement of junior faculty proposal development and early career success.

Conducting research and developing proposals are extremely challenging for junior faculty in a teaching school like Fisk University. The challenges include heavy teaching loads, lack of knowledge in proposal writing, lack of advice from senior faculty members, and lack of opportunity to find new collaborators. This was especially difficult for me because my prior research area was mainly theoretical and did not fit most grant opportunities. I needed to extend my research to more practical subjects and develop stronger proposals. Fortunately, I was selected to participate in the QEM HBCU-UP Education Research Professional Development and Mentoring (PDM) Program. This program has helped me tremendously in developing proposals, extending research to new areas, teaching, and mentoring undergraduate research assistants.

I benefited most from the program’s proposal development guidance. I had never developed any NSF or NIH proposal before I entered the PDM program. I knew very little about the NSF proposal evaluation process, available programs, and the importance of contacting Program Directors prior to proposal submission. The PDM program helped me to learn the correct format for a proposal, how to plan a budget, and how to run a program effectively.

The PDM program helped me with many aspects of proposal development. Firstly, PDM proposal development workshops were very helpful. Since the beginning of the PDM program, I attended seven PDM workshops. Almost all these workshops included sessions regarding proposal development. Current and past NSF Program Officers, successful NSF awardees, and
higher education administrators were invited to give presentations. They provided very useful information for proposal development. I learned about funding opportunities and their specific goals, budget requirements, and evaluation processes and criteria. I also learned how to make a proposal more attractive to reviewers, and mistakes applicants should avoid. Participants in the PDM program received invitations to and attended additional proposal development workshops hosted by QEM, including an Early Faculty Career Development (CAREER) proposal workshop, an HBCU-UP education research proposal workshop and a Research Initiation Awards (RIA) proposal development workshop. These workshops provided more specific information for these programs and Program Directors presented more details for applying to their programs.

“I benefited most from the program’s proposal development guidance.”

Secondly, QEM appointed Professor Wayne Lutters as my research mentor. Professor Lutters is an outstanding computer scientist. He was an NSF program director and is very knowledgeable about proposal development. He gave me great advice on how to select research topics, plan the budget, contact Program Directors, and write good intellectual merit and broader impacts proposal sections. Dr. Lutters also spent a lot of time revising my project summaries and full proposals and gave me very valuable feedback.

The QEM PDM program also helped participants make connections with NSF Program Directors. I contacted Program Directors Claudia Rankins, Nina Amla, and Martha James in person during PDM workshops and by phone. They provided me very helpful information regarding their specific programs. Finally, the PDM program provided release time and summer research funding, which was critical to my developing research programs and proposals.

**ACHIEVEMENTS**

With the help of QEM, I have developed six proposals as PI or co-PI since joining the PDM program. Three of these proposals were funded (two as PI and one as co-PI). In early 2013, my proposal, “Targeted Infusion Project: Development of an Undergraduate Bioinformatics and Biomathematics Track to Enhance Undergraduate STEM Education and Research and Future Careers for Students at Fisk University,” was funded. I serve as co-PI on this project, which was funded for $400,000 for three years. This project aims to enhance and expand undergraduate STEM education and research at the interface of mathematics, biology, and computer science at Fisk University. With this grant, we developed three new courses at Fisk University. I co-developed two of them (“Bioinformatics” and “Mathematical Modeling for Biological Systems” with Dr. Nelms and Dr. Hota, respectively).

With the support of this grant, we established a new collaboration with Dr. Yaohang Li of Old Dominion University and Dr. Ashraf Yaseen of Texas A&M University-Kingsville to perform bioinformatics research. Our students also benefitted from this project and the collaboration. They did summer research for the project and became the coauthors of a paper published in an international conference [1-6]. This project also brought collaboration with the Quantitative and Computational Biosciences Institute of UCLA.
Inspired by our success in the NSF HBCU-UP TIP project, in 2015, I wrote a proposal to the NIH BD2K (Big Data to Knowledge) R25 program, for which I would serve as PI, and was funded recently ($1M/5 years). This project will establish a partnership with the KnowEnG BD2K Center at the University of Illinois at Urbana-Champaign and the Mayo Clinic, and foster collaborative faculty research in Big Data areas as well as train Fisk students through enhanced curricula, newly developed courses, and summer research opportunities.

In addition to curriculum and research training program elements, Fisk students will have remote access to seminar courses to increase their efficacy in communicating BD2K-based technologies and their applications. Didactic work and undergraduate research experiences will be complemented by an individualized student development plan for honing professional skills, deep understanding of the responsible conduct of research, and wrap-around mentoring to assure subsequent successful entry into competitive BD2K aligned PhD-granting programs. UIUC-hosted summer workshops for faculty will increase their confidence in use of Big Data tools, leading to innovations in STEM courses that embrace Big Data, impacting all Fisk STEM undergraduates.

In addition to these proposals, I also was awarded a grant from Hewlett Packard to promote online education and relevant research (PI, $150K/2 years) in 2011. I also submitted one proposal to the Air Force Research Lab—“Centers of Excellence: Autonomy, Cyber Security, and Research Data Analysis in Fisk University” (co-PI, 2014)—and three proposals to NSF: “Integrating Authentication Logic with Other Formal Methods for Verifying Security Protocols” (PI, 2012); “BIGDATA: Mid-Scale: DCM: ESCE: Development and Evaluation of a Secure Cloud Technology for Massive Data Storage and Sharing” (co-PI, 2012); and “Fisk University CREST COUNTS Center: Designing, Synthesizing and Simulating Passive Optical Logic Devices” (co-PI, 2013). Even though they were not funded, the comments we received were very helpful to us in receiving the most recent NIH BD2K grant.

“the QEM PDM program greatly impacted my career development and helped me successfully transition from junior faculty to mid-career faculty.”

**In summary**, the QEM PDM program greatly impacted my career development and helped me successfully transition from a junior faculty to mid-career faculty. In addition to proposal development, PDM supported my research with release time, supplies, and senior faculty mentoring. Without the support from the PDM program, I would not have been able to extend my research from my previous research areas to bioinformatics and get my proposals funded. PDM workshops also help junior faculty like me to improve the effectiveness of classroom teaching and student mentoring. Lastly, the program helped me to be promoted to associate professor and to receive tenure.
REFERENCES


ABOUT THE AUTHOR

Lei Qian is Associate Professor of Computer Science in the Department of Mathematics & Computer Science at Fisk University in Nashville, TN. Dr. Qian’s current research interests include optical computing, pure and applied logics, formal methods, computer security, pattern recognition, data mining, bioinformatics and grid computing. His research has been funded by NSF, NOAA, MDA, AFOSR and Hewlett Packard. Dr. Qian currently serves as PI/Co-PI on funded research awards in bioinformatics and biomathematics from the NSF HBCU-UP and the NIH BD2K R25: Fisk University/UIUC-Mayo ENG BD2K R25 Center Partnership. He also is campus PI of the NOAA Interdisciplinary Scientific Environmental Technology Cooperative that provides research opportunities for undergraduate students.

Dr. Qian’s publications include articles in professional journals, book chapters, and conference proceedings on computer science topics. He is a member of the Association for Computing Machinery (ACM) and Sigma Xi. Dr. Qian received the B.S. and M.S. degrees in Mathematics from Nanjing University and the Ph.D. degree in Mathematics from the National University of Singapore. He received the M.S. degree in Computer Science and the Ph.D. degree in Computer Science and Mathematics from Indiana University Bloomington.
The Impact of Strong Mentoring

Ulrica Wilson
Department of Mathematics
Morehouse College
Atlanta, GA 30314

Summary

A highlight of the program for me was the mentoring that I received from Dr. Camille McKayle. The culture of academic disciplines and academic institutions can be quite different and so it was important for me to get direct input from a senior colleague (outside of my own institution) who is familiar with the specific issues regarding research, research with students, grant writing and tenure and promotion in mathematics and at an HBCU.

As I transitioned from a postdoc at a research-intensive institution to a tenure-track position at an HBCU, the release time funded by QEM’s Professional Development and Mentoring program (PDM) allowed me to continue a high-level of engagement with research collaborators that I could not have maintained without PDM program support. Support from PDM also allowed me to really develop how I work with undergraduate students on research projects. But the biggest impact of the PDM program for me was in writing grant proposals.

Before participating in the PDM program I had very little experience writing and submitting proposals to the National Science Foundation (NSF). I had written one proposal that was declined and I had attended a grant-writing workshop for STEM faculty sponsored by NSF. While the NSF grant-writing workshop—facilitated by a bench scientist—provided good ideas on how to make my proposals more competitive, I struggled with how to translate much of the given advice to research mathematics.

This is where the QEM PDM program really made a difference. The PDM program connected me to someone in my own discipline, familiar with the challenges at HBCUs and who was also a former NSF program officer—Dr. Camille McKayle.

Some key pieces of advice from my PDM mentor that made a difference for me included specific information on how to address NSF’s mission directly to my work and plan for engaging
undergraduates. Dr. McKayle also helped to figure out how to illustrate relevant examples of my past work without diminishing the innovation of my proposed work. I was also struggling with how to address broader impacts when there is an intrinsic broad impact just because I would be working with Morehouse students.

“A highlight of the program for me was the mentoring that I received from Dr. Camille McKayle.”

Since participating in the PDM program I have been awarded four grants (as principal investigator)—three from NSF and one from NSA—totaling over $700,000 in funding.

While unrelated to grant-writing, I will end with another important example of the impact of Dr. McKayle’s mentorship that came while I was preparing my tenure dossier. There was an inconsistency between Morehouse’s procedure for collection of external letters and the expected procedure from one of my external letter writers. Not knowing exactly how to manage this conflict, I would have omitted this letter. Then I decided to reach out to my PDM mentor and she gave me great ideas on how to navigate around this hurdle. Ultimately I know this letter, along with the research grant I was awarded, added to the strength of my dossier.

ABOUT THE AUTHOR

Ulrica Wilson is Associate Professor of Mathematics at Morehouse College in Atlanta, GA. Dr. Wilson’s research interests include noncommutative ring theory: specifically, finite-dimensional division algebras and the Brauer group; and combinatorial matrix theory. Since 2010, she has served as Interim Co-Director of the Minority Biomedical Research Support (MBRS) Research Initiative for Scientific Enhancement (RISE) program at Morehouse.

Dr. Wilson currently is active in initiatives of the American Institute of Mathematics (AIM) that are focused on mentoring and providing undergraduate research opportunities for students in mathematics. She also serves as Co-Director of the Enhancing Diversity in Graduate Education (EDGE) program to assist recent graduates in mathematics to successfully transition to graduate studies. Dr. Wilson received the B.S. degree from Spelman College, the M.S. degree from the University of Massachusetts, Amherst, and the Ph.D. degree, all in Mathematics, from Emory University.
Reflections on Five Years of Research Experience as an Assistant Professor at North Carolina Central University

Fei Yan
Department of Chemistry
North Carolina Central University
Durham, North Carolina 27707

Summary
Today, many HBCUs face tough issues related to sustainability, cost, quality, and mission, which will require creative approaches and solutions from all stakeholders. This unique Professional Development and Mentoring (PDM) program addresses two of the most important issues facing faculty, in particular junior faculty, at HBCUs: time for research and resources for undergraduate scholarly activities. My participation in the PDM program has enabled me to define and sharpen my research focus and obtain critical preliminary data; and has helped me enormously in further developing my networking, student mentoring, and proposal writing skills. Having worked as an assistant professor at North Carolina Central University (NCCU) for five years, I have gradually learned how to prioritize my time for teaching, research, and service. This essay provides a personal account of four project features associated with the PDM program, including: 1) release time; 2) engaging undergraduates in research; 3) learning to write proposals; and 4) getting to know the National Science Foundation (NSF).

Introduction
North Carolina Central University (NCCU), located in Durham, NC, near the world-renowned Research Triangle Park, is one of the 17 constituent institutions in the University of North Carolina (UNC) System and the first public university for African Americans in the country. In 2015, NCCU conducted its 125th annual commencement exercises. Witnessing the graduation of 660 baccalaureate degree students, some of whom I have known as a course instructor and/or a research mentor, I could hardly believe that I had just completed my fifth year as an assistant professor here at NCCU. Looking back, I can proudly say that I have fully lived up to the expectations specified in the application package of the three-year HBCU-UP Faculty Professional Development and Mentoring (PDM) Program, developed by the Quality Education for Minorities (QEM) Network. The program's effect on my career development has been immense. This reflection is addressed directly to beginning faculty in an effort to share my first-hand research experience in making a smooth transition into a fulfilling and rewarding career at an HBCU.
Release Time

Creating and sustaining a culture of support and excellence for tenure-track junior faculty involves people at all levels of the institution, including the president/chancellor, provost, deans, department chairs, and senior faculty [Trower 2012]. More often than not, release time is one of the “Elephant in the Room” issues that nobody wants to address. NCCU does not offer startup money or a reduction in teaching load for newly hired faculty. The normal instructional teaching load at NCCU is 12 hours per semester for undergraduate courses and 9 hours per semester if teaching only graduate courses. Due to the time commitment and stress of teaching, it can be quite challenging for new faculty to initiate a productive research program. The PDM program enabled me to take a one-course reduction per semester during the academic years 2011-2013, which really accelerated my research productivity. During the three-year span, I managed to submit a total of eleven proposals with myself as the PI or co-PI (five of them were subsequently funded), and published six papers in peer-reviewed journals.

Engaging Undergraduates in Research

At the beginning of my academic career at NCCU, recruitment of undergraduate researchers was accomplished through a combination of research presentations during the department’s annual Chemistry major meet-and-greet gathering and during the departmental bi-weekly/monthly seminar series. With the funding from the PDM program, I was able to recruit two female African-American undergraduate students for my research. Subsequently, some other students signed up for my research course.

My mentoring plan was created following the 4-stage mentoring concept reported by Dr. Malachowski [Malachowski 1996]. Specifically, all undergraduate researchers were involved throughout the entire research process by participating in the following activities: (1) literature review; (2) research execution; and (3) data analysis. All of the activities were properly documented in an electronic notebook for discussions. The student researchers were exposed to a variety of experimental skills and instrumentation, which I personally reviewed with each student before they were allowed to conduct experiments independently. I had some of the more motivated students write their own conference abstracts, while I proofread all of their final presentations. I maintained daily interaction with each of them so I could address any concerns they might have during their research. Meanwhile, I monitored the research progress by requesting a timely submission of their raw data and/or electronic lab notes.

One of the lessons I learned about mentoring undergraduate researchers was that one should set realistic expectations that students can fulfill. The research questions should be designed properly so that the student trainees can have achievable goals and measurable outcomes, given the limited amount of time they have for research experiments. Over a five-year period, I have worked closely with fifteen undergraduate students, ten of whom were included as co-authors in four peer-reviewed journal papers (three of which had an undergraduate as the first author), and who have helped prepare ten regional and/or national conference presentations (three of which had an undergraduate presenter).
Learning to Write Proposals

For a new assistant professor whose credentials are yet to be proved, research funding can be difficult to obtain. My first grant application from NCCU (which was submitted to the American Chemical Society’s Petroleum Research Fund in November 2010), received an unfavorable review. Fortunately, there came along the QEM PDM program, which kindly provided me a package of things that allowed me to get started with my research in full swing. My first summer research as a faculty member jump-started upon my receipt of an internal grant—the Faculty-Student Scholarly/Creative Productivity Initiative, supported by the Office of the Provost at NCCU—which provided funds (in the amount of $4,200) to purchase necessary lab chemicals and supplies and to pay one undergraduate student for a period of five weeks. Such internal funding opportunities are essential, especially for junior faculty who receive no start-up funds, to obtain preliminary data in order to increase competitiveness for external grants.

The funding agencies I applied to range from non-profit organizations (e.g., Research Corporation and RTI International), state agencies (e.g., North Carolina Space Grant), and federal agencies (e.g., DOD, NASA, and NSF). I have also expanded my pure scientific research to education research so that I can make progress on both research and teaching fronts. So far, as a Principal Investigator (PI), I have received over $650,000 of external funds from state and federal agencies, in addition to funding from a non-profit organization, and I was one of the Co-PIs on a $496,000 one-year instrument grant awarded by the Department of Defense. Currently, I am listed as a Co-PI on three pending federal grant applications (one to the National Aeronautics and Space Administration and two to the National Science Foundation), with a total request of ~$5 million.

“Such internal funding opportunities are essential, especially for junior faculty who receive no start-up funds, to obtain preliminary data in order to increase competitiveness for external grants.”

To me, the most rewarding, albeit sometimes nerve-racking, aspect of the QEM PDM experience was the timely submission of mandatory progress reports. Each report was required to include the proposed research to be conducted/research questions to be pursued during each period and the preliminary data to be gathered to assist in the preparation of a competitive NSF research proposal, as well as specific activities relevant to four different types of objectives, namely:

1. research-specific;
2. collaboration-focused;
3. professional/skills development-focused; and
4. dissemination-focused.

While such a structured, deadline-driven approach may not be suitable for everyone, it did help me a great deal in defining and sharpening my research focus.
“… a personal account of four project features, including: 1) release time; 2) engaging undergraduates in research; 3) learning to write proposals; and 4) getting to know the National Science Foundation (NSF). “

**Getting to Know NSF**

One of the key components of the QEM-hosted workshops was the delineation of the NSF grant application process. On January 14-15, 2011, I attended my first workshop, the QEM/NSF Chemistry Proposal Development workshop. During this and subsequent workshops, I have interacted extensively with several QEM consultants (especially Dr. Costello Brown and Dr. Casonya Johnson), who helped me proofread project summaries and provided detailed comments on the research description of my first research proposal to NSF, which was later funded. QEM also organized a group trip to NSF, so each of the PDM members had the chance to chat with several program officers in the relevant fields.

On April 16-17, 2012, I had the opportunity to serve on a panel to review proposals for the NSF’s Environmental Chemical Sciences Program. And, in January 2015, I served as an *Ad Hoc* proposal reviewer for NSF’s Centers of Research Excellence in Science and Technology (CREST) program. Through these experiences, I gained first-hand knowledge of the peer review process at NSF and learned how to avoid common problems with proposals. On April 19, 2014, I was invited to give a presentation on how to write a successful RIA proposal in one of the QEM-sponsored professional development workshops. And I was pleasantly surprised to meet some of the new RIA award grantees at the 2015 HBCU-UP/CREST PI/PD Meeting (February 18-19, 2015), who approached me to thank me for sharing my insights with them.

**Conclusion**

As indicated in NCCU’s mission statement, “Teaching, supported by research, is the primary focus of the university,” NCCU is still in the midst of a transition from a traditional teaching-oriented school to a research-intensive institution. Despite many advances made in research and scholarly activities, NCCU STEM programs severely suffer from the low number of undergraduate STEM degrees produced. While NCCU’s undergraduate student enrollment averaged 680 over the period 2008-2014, an average STEM baccalaureate degree production of only 76 clearly suggests that student retention and persistence in STEM majors at NCCU are significant problems [NCCU 2014]. “We need this university and all Historical Black Colleges and Universities (HBCUs) not just to survive, but to thrive going forward if we hope to have stronger communities and a stronger nation,” said U.S. Secretary of Education Arne Duncan, who delivered the undergraduate commencement address at NCCU on May 9, 2015.

The future of NCCU is undoubtedly bright, but it would certainly require far more drastic changes than have been brought about in the past. At the time of writing, an undergraduate student who previously did her research under my direction for more than two years emailed me that she was recently accepted into the Ph.D. Program in Biomedical Sciences at the University of Miami. It is wonderful news such as this that renews our sense of purpose as college professors and helps us stay motivated for the emotionally demanding task of research and teaching.
REFERENCES / BIBLIOGRAPHY


ABOUT THE AUTHOR

Fei Yan is Assistant Professor in the Department of Chemistry at North Carolina Central University (NCCU) in Durham, NC. Prior to joining the faculty at NCCU, Dr. Yan completed postdoctoral fellowships at The University of Michigan in Nanomedicine and at the Oak Ridge National Laboratory in Nanophotonics. His research interests include: Analytical Chemistry, particularly chemical and biological sensor development; Materials/Nanoscience, focused on Synthesis and characterization of one-, two- and three-dimensional plasmonic nanostructures; Multifunctional nanocarriers for medical diagnostics and therapy; and Integration of authentic research experiences into undergraduate chemistry courses.

As Principal Investigator (PI) or Co-PI, Dr. Yan has received support from the NSF for his disciplinary research as well as integration of education and research interests. He has published his research findings in over 30 publications, including the Journal of Forensic Research and Chemical Communications. Dr. Yan has served as an ad hoc proposal reviewer for the NSF CREST program, the American Chemical Society, and the U.S. Army Research Office. He serves NCCU as a member of the faculty senate. Dr. Yan received the B.S. degree in Chemistry from Jiangxi University, the M.S. degree in Radiochemistry from Peking University, and the Ph.D. degree in Analytical Chemistry from the State University of New York (SUNY) in Binghamton, NY.
Research and Teaching
at North Carolina Central University

Gaolin Milledge
Department of Mathematics & Computer Science
North Carolina Central University
Durham, North Carolina 27707

Summary
Currently, historically black colleges and universities (HBCUs) focus their efforts on enrollment, retention, and graduation rates. To achieve this goal, a strong and dedicated faculty community is essential. With a far-reaching insight into this mission, Quality Education for Minorities (QEM) Network provided Professional Development and Mentoring (PDM) opportunities for selected HBCU faculty members. As a participant in the PDM project, my teaching and research capability increased significantly during the course of program. I learned to more effectively balance teaching, research, and family life. Here, I would like to share some of my PDM experiences in the following aspects: (1) integrating research and teaching; (2) release time; (3) proposal writing; and (4) collaborations.

Introduction
North Carolina Central University (NCCU) is the nation’s first state-supported public liberal arts college founded for African Americans. Through its long history, dating from 1910, its mission has been to offer a strong and challenging educational and research environment that prepares students to “advance the consciousness of social responsibility in a diverse, global society”. Eight years ago, I joined NCCU faculty with a dedication to provide quality education for minority students. As I enjoyed my teaching I found that it was very hard to do research due to lack of release time. My research productivity was very low for the first 3 years here at NCCU. Luckily, I was chosen to participate in the three-year HBCU-UP Faculty Professional Development and Mentoring (PDM) Program, developed by the QEM Network.

The program’s impact on my career development has been immense. Now I am a tenured associate professor. I would like to share my experience as a researcher and educator here at NCCU.

Integrating Research and Teaching
It seems to me that only in highly selective research institutes or private colleges with talented and highly motivated students one can integrate research and teaching effectively. I have been integrating research into my graduate classes. I often add a few selected topics into my graduate course syllabi. The selected topics are typically related to my current research. Most of
my supervised Master theses originated from these selected topics. And some of them eventually turned into publications (Hadush, Zheng, Chen, & Huang, 2011; Jia, Tian, & Zheng, 2011; Zheng, Tesfay, Huang, & Tokuta, 2013). These publications and research experience helped my students find good jobs or get admission to prestigious institutions such as Dartmouth College. To save resources, these graduate courses are typically offered together with an undergraduate course with slightly lower requirements.

To my surprise, some of the undergraduate students are so good that they can perform as well as the graduate students. Naomi Bouleware was one of my brilliant undergraduate students. I asked her to participate in one of my projects. It was an enriching experience for me. I actually learned a lot from her. I learned that setting clear expectations and giving detailed instructions are important when working with undergraduates.

**Release Time**

The normal teaching load at NCCU is 12 hours a semester for undergraduate courses and 9 hours a semester for graduate courses. In order for junior faculty to do some research, our department chair managed to give us 3 courses per semester. However, I often had to supervise graduate students and teach independent studies besides the assigned courses. It was almost impossible to find a block of time to conduct research. As a mother with a small child, it was very stressful and I felt somewhat burnt out. The release time from PDM was a game changer for my research productivity and family life. I was able to conduct more research which resulted in more publications and my mentoring capacity also increased significantly. I have supervised 7 master theses here at NCCU. One of my master students is currently studying for a Ph.D. at Dartmouth College. I also mentored undergraduate students. One of my undergraduate mentees is pursuing a Ph.D. at North Carolina State University. Additionally, I was able to publish 9 peer reviewed journal or conference papers.

Without release time and financial support from PDM, it would have been impossible to accomplish all of this. These accomplishments contributed significantly to my tenure award here at NCCU.

> “The release time from PDM was a game changer for my research productivity and family life.”

**Proposal Writing**

I started my teaching career at NCCU as a fresh Ph.D. graduate. I had not written any proposals before. I did not have enough confidence because I had not published enough to establish myself in my research field. Furthermore, I was not motivated enough because getting grant money is not required to get tenure here at NCCU. Encouraged by Dr. Kim from Physics department, I tried to write my first proposal to a local grant agency. I learned a lot from this process. Most difficult part is to come up with a project that matches with my research experience and the mission of the grant agency. Fortunately I received my first grant. Although it was a small grant, my confidence grew. I also learned that it is important to be aggressive in terms of getting grant money. As a naturally shy and passive person, it was a big challenge.
At the same time, I realized that many grant agencies were giving incentives to junior faculty. In particular, QEM is a big player in engaging junior faculty from HBCUs in research and networking researchers and mentors from HBCUs across the states. I was lucky to be chosen as one of the participants in QEM’s PDM program. The QEM workshop on grant writing was particularly useful for me to understand NSF’s grant application process. QEM also organized a trip to NSF where each of us had the opportunity to meet NSF officers in person. I was able to talk to three NSF officers including Dr. Basu, Dr. Forbes, and Dr. Kimbrel. Dr. Basu recommended the joint initiative between DMS and NIGMS as a more appropriate venue for my grant proposals.

Throughout the PDM project, I submitted 3 NSF proposals and 2 NIH proposals. I did not get much luck with my NSF proposals. My NIH proposals were a little bit more successful. However, the lessons I learned from the PDM program are priceless.

Collaborations

As a researcher in Bioinformatics, I used to work on published biological data. It was difficult to publish that kind of work since the data was secondary and had been used before. It was more rewarding to work with data freshly generated from biology labs. Luke from NCCU’s BBRI approached me with his esophageal gene expression data. His lab was active in finding best animal model for Gastroesophageal reflux disease. I worked closely with his Post-Doc and provided assistance in terms of experimental design and data analysis. Our collaboration resulted in a journal publication (Ren et al., 2014). Our collaboration continues to this day. I also collaborated with Dr. Andy Li from NCCU BRITE in analyzing his medical image data. Our joint work was recently submitted for journal publication.

Within my department, I collaborated with my colleagues and published several papers together (Huang, Kim, Huang, Zheng, & Tokuta, 2012; Mingpei Liang, Huang, Chen, Zheng, & Tokuta, 2014; M. Liang, Zheng, Huang, Milledge, & Tokuta, 2013). Externally, I collaborated with Dr. Johnson from Georgia State and our collaboration resulted in a journal publication (Quach, Chou, Wang, Milledge, & Johnson, 2013).

Conclusion

According to the U. S. Department of Commerce, STEM occupations are growing at 17%, while others are growing at 9.8%. In spite of the trend, I have witnessed the constant struggle of STEM programs here at NCCU. I am very grateful for the QEM PDM program that helped me grow and support NCCU undergraduate research. This program together with other state and national funding agencies contribute greatly to make sure STEM programs at HBCUs such as NCCU survive and thrive.
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ABOUT THE AUTHOR

Gaolin Zheng Milledge is Associate Professor of Computer Science in the Department of Mathematics and Computer Science at North Carolina Central University (NCCU) in Durham, NC. Dr. Milledge’s research foci include graphical models, data integration, and biological network analysis. Her publications, as author or co-author, include ten articles in professional journals and two book chapters on computational and bioinformatics-related topics. Dr. Milledge has served as Principal Investigator (PI)/Co-PI on funded research awards in bioinformatics and computational biology and chemistry from NSF HBCU-UP and the NIH-funded NCCU National Center on Minority Health and Health Disparities Research Center of Excellence. She also has developed software, including AERS/Miner, a Web Data Mining Service for FDA Adverse Event Reporting System.

Dr. Milledge is a member of the Institute of Electrical and Electronics Engineers (IEEE) and the Association for Computing Machinery (ACM). She has served NCCU in a variety of areas, including undergraduate research training; and as a participant in the Women and Mathematics Mentoring Program for Durham and Wake County. Dr. Milledge received the B.E. degree in Biomedical Engineering from the Huazhong University of Science and Technology in China, the M.S. degree in Environmental Biology from the Chinese Academy of Sciences, and the Ph.D. degree in Computer Science from Florida International University.
ABOUT THE QEM NETWORK

The Quality Education for Minorities (QEM) Network was established in July 1990, as a non-profit organization in Washington, DC, dedicated to improving education for minorities throughout the nation. It is the successor organization to the MIT-based QEM Project that was funded by the Carnegie Corporation of New York. With initial support from Carnegie and MIT, QEM began its operation as a focal point for the implementation of strategies to help realize the vision and goals set forth in the QEM Project's January 1990 report: *Education That Works: An Action Plan for the Education of Minorities*.

QEM seeks to put into practice the recommendations in the QEM *Action Plan* by working with minority and non-minority individuals, organizations, and institutions around the country to help coordinate and energize efforts to improve the education of minorities, particularly in STEM. The QEM Network engages in activities designed to:

- Promote, and disseminate information on, promising research results on the education of minorities, and serve as a resource in evaluating educational programs and projects;
- Stimulate and assist in the development of programs to increase the number of minorities in science and engineering fields;
- Implement a series of workshops in areas of special interest such as the under-participation of minority males in STEM and concerns of women STEM faculty at Hispanic-serving institutions;
- Provide technical assistance to faculty and administrators at minority-serving institutions (particularly Historically Black Colleges and Universities, Tribal Colleges and Universities, and Hispanic-serving Institutions) in the development of their proposal ideas into competitive proposals for submission to: cross-directorate programs at NSF such as CAREER and Major Research Instrumentation; programs in the Foundation’s Education and Human Resources Directorate such as Math and Science Partnerships, Innovation through Institutional Integration, Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), and Tribal Colleges and Universities Program (TCUP); and programs in NSF Research Directorates;
- Assist new STEM project directors through workshops and campus visits in the successful implementation of their funded multi-year projects, particularly during the initial years; and
- Strengthen the leadership capabilities of STEM faculty, staff, and students at minority-serving institutions, particularly at HBCUs and Tribal Colleges and Universities, to help ensure greater diversity in the leadership of campus-based STEM projects. Pathways to leadership development have included Leadership Development Institutes for STEM faculty at TCUs and HBCUs; Health-focused Student Summer and Academic Year Internships; Summer Student Science Internships and short-term Academic Year Faculty Appointments at NSF; and Research Appointments at major NSF-funded Research Centers.

This unique array of opportunities and approaches has enabled QEM to establish an extensive network of STEM faculty, administrators, and students and to successfully engage in a range of institutional and individual capacity-building activities. Strategies employed and lessons learned from the implementation of one project inform approaches in other projects. With the assistance of experienced STEM consultants and evaluators, QEM offers high quality technical assistance, encouragement, and follow-up support to chief academic officers, STEM faculty, and STEM students at a range of minority-serving institutions as well as underrepresented minority faculty at non-minority institutions.