International Journal of Gender, Science and Technology
http://genderandset.open.ac.uk

Effects of an External Mentoring Program in a Department of Mathematics

Edgar Fuller, Jessica M. Deshler, and Marjorie Darrah,
West Virginia University, USA

ABSTRACT
In this case study we describe the historical representation of women in the Department of Mathematics at West Virginia University (WVU) and an external mentoring program that has allowed some of these women to achieve individual professional goals and build long-term collaborations supporting their overall success as faculty members. We describe the University-wide program as well as its specific implications in mathematics and how some of the colleges within WVU have institutionalized the program for all incoming faculty members. While faculty from 16 departments were eligible to participate in the program we focus on the impact of the program on the Department of Mathematics in order to look at its history and the large impact the program has made on this department. We end with some recommendations about the limitations of the institutionalized version of the program.

KEYWORDS
Mentoring, ADVANCE Grant, female faculty, faculty support

Effects of an External Mentoring Program in a Department of Mathematics

INTRODUCTION

According to the latest American Mathematical Society (AMS) Department Profile Report (Vélez, Maxwell & Rose, 2015) for doctoral-granting mathematics departments, which included public institutions, private institutions and applied mathematics programs, women comprised 15% of the doctorate-holding tenured and tenure-eligible faculty positions. For the non doctoral-granting mathematics departments (highest degree granted is either a Bachelors or Masters), which included public institutions, private institutions and applied mathematics programs, women comprised 30% of the full-time tenured or tenure-eligible faculty. Among the non-doctoral full-time faculty in all mathematics departments combined, women comprise 54%. In this paper, we examine the history of women faculty representation within our department, a doctoral-granting Department of Mathematics at a public university, and present the effect of a mentoring program for some of the current female faculty members within the Department.

Women in Mathematics at WVU

WVU is a large, public, doctoral-granting, research institution serving the state of West Virginia and the Appalachian region of the eastern United States. Two women first held tenure-track positions in the WVU Department of Mathematics in the early 1920s; one from 1922-1929 (and again from 1938-1955) and the other from 1923-1947. In the years after these two women, one additional woman (who started as the department secretary) subsequently became part of the faculty. There have been numerous women over the years serving as instructors; many high school teachers trained at WVU who came back to teach, but these three women represent the only persistent female faculty members in the Department through the 1950s. After the 1950s, the role of women in the Department was largely as service personnel, teaching lower-level undergraduate courses, with numerous women having at most a master's degree. One female faculty member was hired in the 1960s, but she left soon afterwards, leaving the Department with no female faculty members. In 1995, the Department hired a female part-time instructor. Upon completion of her EdD., her position became tenure-track and in 2005 she was tenured and promoted. She became the first female faculty member to be promoted to Full Professor in the Department (in 2011). In the early 2000s, two other females were hired in tenure-track lines, but one left before receiving tenure and one right after receiving tenure. Currently, there are six women in tenure-track positions in our Department (22% of Departmental tenure-track lines) – one Full, three (recently tenured) Associate and two Assistant Professors. With the historic lack of presence of women in our department, it was very important that these faculty members persist and succeed. The University and the Department were looking for ways to retain and promote these women (and others) in key STEM departments.

MENTORING AND ADVANCE AT WVU

The focus of support for female faculty at WVU has shifted in recent years from hiring to retention and mentoring. It is in the best interest of academic institutions and departments to foster the careers of its faculty members through various initiatives to ensure success. Reviews of research on mentoring have shown that even among formal academic mentoring programs, program structures can vary greatly (Jacobi, 1991). Despite these differences, there is general acceptance of benefits for both the mentees and the mentors in mentoring relationships (Ehrich, Hansford and Tennent, 2004).

In addition to the need for general mentoring related to institutional policies and procedure, how to progress through the promotion and tenure process, and how to navigate the day-to-day teaching and/or service schedule, there is often a need for mentoring in the area of research. It may be difficult to find even an informal mentor when an academic department has newly stablished programs with faculty members in research areas outside the expertise of existing, tenured faculty members. This can especially be the case for women faculty members in departments where men have traditionally held the majority of tenure-track or tenured positions, such as in mathematics. However, researchers note that finding a suitable mentor is 'crucial to the success of mentoring relationships' (Bell and Treleaven, 2011, p. 545). In a national survey (AAUW, 2010) women have reported that formal mentoring is much more important for them than their male counterparts and the lack of a potential mentor has been identified as a problem in women's mentoring experiences (Chandler, 1996).

In 2010, WVU received a National Science Foundation (NSF) 'Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers' (ADVANCE) award focused on recruiting, retaining and promoting women in STEM and Social and Behavioral Sciences (SBS) departments. Through this award, various initiatives were put into place, including an external mentoring award program, the WVU ADVANCE Sponsorship Program. Sponsorship awards provide resources to female faculty in STEM departments to establish mentoring relationships with successful external faculty or industry researchers. The WVU ADVANCE Sponsorship Program has created an opportunity for female faculty members in STEM disciplines to develop long-term relationships with external mentors to support their careers. However, the idea of *sponsorship* is somewhat different to mentorship. Hewlett (2013) explains

> *"Mentors act as a sounding board or a shoulder to cry on, offering advice as needed and support and guidance as requested; they expect very little in return. Sponsors, in contrast, are much more vested in their protégés, offering guidance and critical feedback because they believe in them. Sponsors advocate on their protégés' behalf, connecting them to important players and assignments. In doing so, they make themselves look good. And precisely because sponsors go out on a limb, they expect stellar performance and loyalty.".*

The Sponsorship Program initiated by WVU ADVANCE has now completed its fourth and final year. The participants in the NSF-funded Sponsorship Program were 29 female faculty members from the 16 STEM and SBS departments at WVU and included Teaching Assistant Professors (faculty with no research responsibilities), and Assistant and Associate Professors who were seeking assistance to move to the next level in their careers. The program required a formal written application and the funding lasted for a year. Applicants were eligible to reapply each year, and some participants were funded two or three times, resulting in 41 awards being given to these 29 participants.

As part of their application, the WVU faculty member (called the Associate) identified a Sponsor - a senior scholar who agreed to work with them for a year. The application described the project they would work on, the potential for long-term collaboration, expected outcomes and the expected impact on the Associate's career in all aspects of their job. Most Sponsors were faculty members at other universities, but some were employed outside academia or, in some cases, within WVU in another department. Both the Associate and the Sponsor were provided with stipends to support their activities; the Associate received $10,000 and the Sponsor received $5,000. Sponsors were encouraged to make at least one visit to the Associate's academic department, and many faculty members also visited their Sponsor,s workplace.

Most Associates chose Sponsors with whom they had an existing relationship of some kind. The Associates also often chose people with complementary interests. In some cases, they were from different disciplines; in other cases their area of specialization (within the same discipline) was different. Among the award recipients in mathematics, both of these occurred. All Sponsors were at a more advanced stage in their careers than the Associates were, and all had well-established research programs. Associates chose Sponsors who they felt would be helpful in ways that mentors from within their departments could not be.

EFFECT OF THE SPONSORSHIP PROGRAM AT WVU

A review of year-end evaluation reports on the WVU ADVANCE Sponsorship Program suggests the Associates in all departments have used their resources well. Associates are able to point to tangible outcomes that are consistent with what they proposed to do, and consistent with what is required of them to be promoted or to achieve continued success in their position (Darrah, Hougland and Jouben, 2015). Some of the research-related accomplishments of the Associates have included travel to research sites, grants submitted (some funded), conference presentations and manuscripts submitted (some published). The Associates were asked to rate their

Sponsors' help on several aspects of the collaboration, including starting a research program, managing research projects, developing publications, securing external funding, enhancing teaching effectiveness, establishing good relationships with department colleagues, and preparing for successful tenure and promotion reviews. In all cases, the Associates reported that their Sponsors were effective or very effective at providing guidance in these areas. In their annual reports, Associates have indicated that they anticipate establishing long-term professional relationships with their Sponsors, and that most of their accomplishments could not have happened without the resources provided by the Sponsorship Program. Because of the apparent success of the program, both of the Colleges that house the STEM and SBS departments at WVU are considering or have already implemented some aspects of the program as part of the start-up package for incoming faculty members (described in more detail later in this paper).

The success can be attributed to three main aspects of the program. First, the Associates and Sponsors were provided with enough money ($15,000 – Associate $10,000 and Sponsor $,) to assist them in furthering their research agendas and facilitate meetings. Some Associates used the money as summer pay for themselves or to hire a graduate assistant, many used the money to travel with or to see their sponsor, or attend conferences together. The Associates told the Evaluators that the money gave them the courage to approach the Sponsor to request a relationship. The Associates agreed that the money given to the Sponsor was not a large amount to an accomplished scholar, and some Sponsors did not take the money, but at least it was a way to open the conversation. Second, the Associates were held accountable by the ADVANCE Center. The Associates wrote a competitive proposal to acquire the funds where they outlined what they would accomplish by working with their Sponsor and how these goals would move their careers forward. Then after awarded the funds, the Associates provided short quarterly reports and longer yearly reports that outlined progress toward their stated goals. Finally, the ADVANCE Center required and provided opportunity for networking. The Associates were required to attend several activities on campus each year where they networked with each other and other faculty members. They were also required to visit the Sponsor's university and have the Sponsor visit their university to give a talk. This facilitated the Associates' introductions to a broader network of scholars in their field. In several cases this led to the Associates writing papers or building collaborations with faculty who were in their Sponsor,s networks.

Effect of the Sponsorship Program in the Department Of Mathematics

Four faculty members in the WVU Department of Mathematics have received eight WVU ADVANCE Sponsorship awards over the four years of the program. Recipients

of the awards consented to participate in our study by voluntarily responding to surveys. One of the recipients is also a co-author on this manuscript.

One Associate received the award three times to work with the same Sponsor over three years to develop, implement and evaluate research-based curricula. This work has been the basis of several published manuscripts, one external grant to the Associate from the Mathematical Association of America and several joint national and international conference presentations. The Associate and Sponsor have also co-chaired paper sessions at national conferences based on the work, providing a venue for other researchers to present their work in the area. While the Associate worked with the same Sponsor each year and the projects were all related, each year of the project had a different focus. It was a requirement of the program that proposals not simply be a continuation of existing collaborations. For example, in the third year of their collaboration, the focus was on data analysis and publication of results (from the previous two years of the collaboration as well as from other projects) given the upcoming tenure review of the Associate.

Two Associates received two awards each. One used the two awards to work with two different Sponsors while one used her two awards to work with the same Sponsor over two years. The first used her first award to work with a senior scholar in her field to develop publishable manuscripts based on completed research (completed before the collaboration, so not with the Sponsor). The Sponsor in this case had an extensive publication record, and was specifically familiar with the publication outlets the Sponsor was interested in pursuing. This award was particularly timely because it was active during the year proceeding the Associate's tenure and promotion reviews. She used her second award (received post-tenure) to form a collaborative relationship with a scholar in another field working on research closely related to her own. The second Associate who received two awards, worked with the same Sponsor over two years to strengthen grant proposals for federal funding. This Associate was pre-tenure at the time of award, and her contract specifically included the receipt of external funding as critical for promotion and tenure. The Sponsor had an established record of external funding and expertise in the area into which the Associate was trying to move. The Associate indicated that despite the proposals not being funded she believed they were stronger after working with the Sponsor.

The fourth Associate from the Department received one Sponsorship award and used it to strengthen a recently formed collaboration in its early stages. Face-to-face time was necessary for their research project to progress, so the award allowed her and her Sponsor to spend more time together visiting each other's institutions.

INSTITUTIONALIZATION OF THE PROGRAM AT THE UNIVERSITY AND IN THE DEPARTMENT

As part of the commitment to institutionalize different aspects of WVU ADVANCE programming, the Office of the Provost provided funds for a matching Sponsorship Program that ran concurrently with the ADVANCE Sponsorship program. The WVU participants in the Sponsorship Program funded under the NSF component of the

program are female faculty members (non-tenured and tenured) from the 16 STEM and SBS departments at WVU. The Provost's portion of the program supports identical Sponsorship activity (external mentoring) for both male and female faculty members from underrepresented groups in any discipline across campus. This allowed any underrepresented faculty member to get the same kind of support in developing long-term external mentoring relationships. (In this case, the term *underrepresented* was broadened to apply to categories other than gender, race and/or ethnicity. Applicants needed only to make the case that they somehow qualified as underrepresented in their field or department.)

The Hiring Process in Mathematics and the College of Arts and Sciences

Perhaps the greatest impact on the Department of Mathematics (and likely other departments) from the various initiatives implemented across campus by WVU ADVANCE has been the incorporation of Sponsorship funds into hiring contracts for new faculty. These arrangements were first negotiated informally in 2012 in the Department for five faculty members hired that year (three women, two men with formal language and terms included in all contract letters beginning in 2013) (two men). The intent was to emulate the ADVANCE Sponsorship program by providing funds in startup packages that specifically require faculty members to identify an external scholar with whom they wish to work. These sponsorship funds were put into place at the Department level in 2013, and in 2014 became a College-level program. The College of Arts and Sciences at WVU now has a formal policy of offering $5,000 to support the development of mentoring relationships as a part of faculty start-up packages. These funds are provided partially by the College (50%) and partially by the Departments (50%).

In its first year (2014-2015) the program has been included in 30 offers across the College at multiple ranks including those with both research and teaching as their primary responsibilities. Funds can be used to support travel and/or salary for both the WVU faculty member and the Sponsor. In the College of Engineering and Mineral Resources at WVU, incoming faculty are awarded $4,000 for Sponsorship activities ($3,000 for travel between faculty members' and Sponsors' institutions and a $1,000 honorarium for each Sponsor).

Modifications of the Program

It should be noted that the institutionalized version of the program is significantly different from the original ADVANCE Sponsorship Program offered at the University. The WVU ADVANCE Sponsorship program was available to any eligible faculty member (female in STEM or SBS), regardless of rank or when they were hired at WVU. The current program is included as part of start-up packages, therefore only available to new hires. The previous program allowed those nearing critical years and critical transitions (e.g. Associate Professors approaching promotion to Full Professors) in their jobs and responsibilities to get some additional support at an essential time.

The WVU ADVANCE Sponsorship Program was competitive and required a proposal that necessitated input from both the Associate at WVU and the external Sponsor. Associates had to describe the expertise of their Sponsor and their ability to help

them succeed in all aspects of their job. The projects had to be well developed with clear outcomes that aligned with tenure and/or promotion requirements for each Associate. Timelines for completing the work had to be specific. Participants were held accountable via quarterly and annual reports. In contrast, participants of the current College-level program are guaranteed the money upon hire, are not required to submit a proposal, and are not required to submit reports indicating which aspects of the project were successful or even completed.

A significant change in funding has also occurred during this institutionalization of the program. The WVU ADVANCE Sponsorship program included a total award of $15,000, a large portion of which could be used as summer salary for themselves to support their work on a project, and $5,000 of it went directly to the Sponsor for their efforts. The current funding is limited to $5,000 in total, which is to be used to support travel, supplies and/or salary for both the WVU faculty member and the Sponsor. This incarnation of the program is new and the effects of these changes have not yet been evaluated.

DISCUSSION

Although there were a few minor problems among individual participants of the program, it is clear that overall the ADVANCE Sponsorship program had a great impact on faculty careers at WVU, and in the Department of Mathematics in particular. Of the four recipients of the award in the Department, two have been tenured and been promoted to Associate Professor since receiving their first award. The other two are pre-tenure and both believe the award has helped their careers and their ability to earn tenure and promotion in the near future. Many of the collaborations have extended beyond the award period. Reports of Sponsorship recipients from other STEM departments at WVU are similar to those of the Department of Mathematics, but one of the most interesting reports is from Computer Science and Electrical Engineering. Two female faculty ADVANCE Sponsorship Program recipients rose to the level of Full Professor, the first in the history of that department.

Considering where the Department of Mathematics at WVU started in its history of hiring, retaining, and promoting women, the Sponsorship program appears to be a factor that is making a significant impact in this respect. The most compelling evidence to support this conclusion is the progression of female faculty who received the Sponsorship awards through the professorial ranks in the department. A large portion of that development occurred as a part of the ADVANCE Sponsorship. It is yet to be seen whether the version developing as a result of the institutionalization of the program, will have the same effect. In particular, funding as a part of start-up does not benefit mid-career faculty, and this cadre of emerging leaders also need mentoring. To begin a preliminary response to this observation, the Department of Mathematics has plans to develop a mid-career mentoring support program to allow faculty to reach out to national leaders for support as they transition to more senior roles. This program is still in development. Departments that wish to implement programs such as this must recognize the need for their faculty to have interaction with colleagues with whom they identify and that these colleagues may necessarily be from other institutions. Programs

such as ADVANCE and mentoring processes in general give faculty an opportunity to find collaboration and inspiration in a larger environment and bring that back to their home institution. That work benefits both the faculty member and the home department in ways that are hard to measure, but most evidently in the ways that empower underrepresented groups in a department to become leaders. More concretely, departments and universities providing the travel and other resources along with the guidance needed to establish mentoring relationships would benefit immensely from the process through stronger faculty productivity and national prominence.

As the WVU ADVANCE grant comes to an end, the WVU ADVANCE team will be discussing with the Provost's office and the office of Creative and Scholarly Activities the benefits of continuing the Sponsorship Program in its original form, i.e. competitive awards, a significant level of support, periodic accountability, and building community among the recipients. The ADVANCE team will attempt to facilitate the continued development of programs and policies that embody the lessons learned from the ADVANCE Sponsorship program and its subsequent and concurrent efforts at the departmental levels. With the significant financial cost and time it takes to recruit, hire and retain faculty members, chairs should take notice of such programs that have the potential to help the retention and progression of their faculty members. As illustrated by the significant changes in the gender composition of our Department, the benefits of such programs to a department (and to a university) are so overwhelmingly positive that they should not be ignored.

Acknowledgement: partial support for this work was provided by the National Science Foundation's ADVANCE IT Program under Award HRD-1007978. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. We would also like to thank and acknowledge Henry Gould, Professor Emeritus and historian, for the history of the WVU Department of Mathematics.

REFERENCES

American Association of University Women, (2010). Why So Few? Women in Science, Technology, Engineering, and Mathematics, AAUW: Washington, D.C.

Bell, A. and Treleaven, L., (2011). Looking for Professor Right: mentee selection of mentors in a formal mentoring program, *Higher Education, 61* (5), pp. 545-561.

Chandler, C., (1996). Mentoring and Women in Academia: Reevaluating the Traditional Model, *National Women's Studies Association Journal*, *8*(3), pp. 79-100.

Darrah, M., Hougland, J. and Jouben, L., (2015). West Virginia University ADVANCE Year 2015 Evaluation Report, Internal Document.

Ehrich, L.C., Hansford, B. and L. Tennent, (2004). Formal Mentoring Programs in Education and Other Professions: A Review of the Literature, *Educational Administration Quarterly*, 40 (4), pp. 518-540.

Hewlett, S.A., (April 13th, 2013). Mentors Are Good. Sponsors Are Better. *The New York Times*. accessed at http://www.nytimes.com/2013/04/14/jobs/sponsors-seen-as-crucial-for-womens-career-advancement.html?_r=0

Jacobi, M., (1991). Mentoring and undergraduate academic success: A literature review. *Review of Educational Research*, 61, pp. 505-532.

Vélez, W.Y., Maxwell, J.W. and Rose, C.A., (2015). Fall 2013 Departmental Profile Report, *Notices of the American Mathematical Society, 62* (4), pp. 406-415.