Recruiting, Retaining and Graduating more Women in Computer Science and Math

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Abstract

We report on the CS/M Scholars Program which is supported by an NSF S-STEM grant that began in 2011. The program aims to increase the number of women graduating with degrees in Computer Science or Mathematics. It is well known that women are underrepresented in these fields nationally and this is also the case at our university. Our efforts include targeted recruitment of female high school students with a record of academic achievement and leadership potential. In addition to providing scholarships, student success is bolstered by required first-year seminars, early advising, and monthly events focused on professional development and expanding awareness of opportunities. All of these activities have fostered a tight-knit learning community and provided ample opportunities for peer mentoring and networking with alumnae.

Because we focus on recruiting first-year students and retaining them through graduation, the program has grown from nine freshmen in the first year to over forty students now who range from freshmen to seniors. Our recruitment efforts have become more successful as the program has grown which we attribute to the active involvement of current students in recruiting and a record of the programs accomplishments. Retention is higher than expected; moreover, retention rates are increasing. Students are excelling academically and have become visible, successful female members of male-dominated departments. This is having a positive effect on the cultures of the departments which is in turn encouraging other female students.

Herein, we provide an overview of the CS/M Scholars program and highlight features that may be adaptable to other institutions without external funding. We report on statistics for recruitment, retention and graduation; share our ideas and experiences for impactful monthly events; explain how conference participation has been transformative for both students and their departments; and discuss funding conference participation with few institutional resources.

We view our work so far as a pilot project in part because the program took four years to grow to its full size. We have recently submitted a new S-STEM proposal that, if funded, will initiate a
design and development project that will include quantitative and qualitative assessment of the achievement of the program’s ultimate goals, which include shifting the demographics of graduates at our institution and observing continued employment of CS/M Scholars in their field.

1 Program Description

1.1 Recruitment

With the aid of staff in the Office of Admissions, we invite high-achieving female applicants with leadership potential to submit a short application. In deciding whom to invite, we consider several broad measures of academic and personal achievement and don’t require that applicants have significant experience in mathematics or computer science. Applicants typically come from the top 20% of WWU applicants academically. The PI and co-PI conduct personal interviews to gauge each applicant’s motivation, interest, communication skills and leadership potential. These practices are designed to create a broad applicant pool which is stated in [1] to be essential to expanding the presence of women. The active recruiting of women into STEM fields is one of the recommendations of [2] to attract and retain female students.

Beyond the involvement of the PI and co-PI in recruiting, the current CS/M Scholars have voluntarily taken part in recruiting starting in the second year of the program. Many CS/M Scholars have identified the experience of meeting students currently in the program as the decisive factor in choosing to attend WWU and participate in the program.

Admissions professionals contribute to our recruitment efforts in several ways. They promote the program on high-school visits, advise the PI and co-PI on recruitment strategies, and keep an eye out for outstanding candidates who fall outside of our normal search criteria. Furthermore, they help by designing and distributing promotional materials, managing the invitation and application process and being part of the program’s advisory board.

1.2 First-year seminars

Each fall we offer two first-year seminars, one in computer science and one in mathematics, which are taught by the PI and co-PI respectively. The seminars are required for all of the incoming CS/M Scholars but several
other students (male and female) outside of the CS/M Scholars Program are invited to participate as well. We limit the class size of these seminars to 20 and teach them in a way that is highly interactive, engaging, challenging and fun. Both the PI and co-PI have been involved in teaching workshops over the years and employ many strategies from those experiences in these classes.

First year seminars in general have been shown to be highly effective (cite the link at the bottom). Our seminars share many aspects with previous research and have several purposes. First, they help to create a learning community of high-achieving students. Equally important, the seminars expose students to topics not normally covered in introductory courses to entice them into further study. For instance, the math seminar has covered topics such as graph theory, cryptography, discrete dynamics, game theory, and selected topics from the Monthly (citation needed?). The computer science seminar has covered topics such as machine learning, binary sequences, human-computer interaction, encryption, circuits, and Scratch Programming (cite Scratch). Showing real world applications and the social impact of math and computer science has been a cornerstone of the seminars’ success. Finally, the seminars help students develop skills that are important to continued academic success such as communication and collaboration skills.

1.3 Monthly Events

After the first-quarter seminars, which all incoming CS/M Scholars are required to take, and a first course in computer programming taken together by most CS/M Scholars in their second quarter, a entire cohort is not likely to take a class together again. To preserve connections among the cohort, we arrange a get-together each month of the academic year. These events range from purely social gatherings to panel discussions with a career focus. We list some examples of our monthly get-togethers below.

- A welcoming potluck exclusively for CS/M Scholars. This is where the continuing CS/M Scholars meet the new cohort. To encourage participation of the first year students, it is the faculty, staff and continuing scholars who volunteer to make food and the first-year students just show up for some home-cooked goodness. This is an example of an event originally proposed by the students.
• Panel discussions with professional women (often WWU alumnae) open to all students (male and female) in math and computer science. The panel discussion format has proven to be very effective because the variety of panelists allows the students a greater chance of connecting to someone. The panelists have commented positively on the format as well because they aren’t always sure how to answer a question so they can defer to someone else on the panel. Usually one of the panels per year is moderated by a couple CS/M Scholars. This keeps the event focused on the students’ questions and concerns.

• Workshops open to all women in computer science and math. We have had a facilitator run a few workshops over the years on topics such as “Women and Ambition” and “Unmasking the Imposter”. These events have focused on the students’ personal and professional development. These students say these workshops have taught them valuable communication skills and exposed them ideas and helped them learn what their individual goals are and how to achieve them. The workshops also help form connections between scholars and other women in the departments.

• End of year gathering to celebrate scholars’ accomplishments. Many of our events are focused on external speakers and motivating scholars. This event focuses on the scholars’ accomplishments throughout the year and we congratulate them in front of the group for those accomplishments.

These monthly events serve many purposes. First, as we said above, the events help to keep each cohort connected as their class schedules start to deviate. The events also help students from different cohorts connect and they help to form a larger community in math and computer science by integrating the scholars with other engaged students in the departments. They also serve to address key issues surrounding the successful participation of women and minorities in these disciplines. We have learned that the most effective events are not necessarily those where the most accomplished women are visiting. Sometimes, an alumna who graduated only a few years before can really relate to the current students and make a lasting impact even though she doesn’t have a career full of accomplishments to talk about.
1.4 Early Advising

We begin advising CS/M Scholars in the summer before their first year. Most WWU students attend Summerstart which is a 2-day orientation session for students. We meet with students at the end of the first day to advise them on appropriate classes to take and ensure that they understand the academic requirements of the CS/M Scholars Program.

In the Fall we meet with the incoming cohort before Winter registration to again ensure that they have a clear understanding of the program requirements. We meet with the first-year cohort again in the Spring to map out a four-year graduation plan. This plan is not set in stone and students often deviate somewhat from the plan. However, it serves to reinforce their commitment to the program and shows them what is required to graduate in four years. The PI and co-PI continue to serve as advisors to the CS/M Scholars through graduation.

1.5 Conference Participation

Our experience has shown us that conferences have been one of the most transformative experiences for the scholars. Conferences can be expensive to attend and while we devoted some of the budget from our current NSF grant to support conference travel, in retrospect we didn’t include enough. Our new proposal to NSF includes more money for conference travel because it has been so impactful for students.

After students attend conferences, we have them give presentations or serve on a panel to tell other students what they got out of the conference and encourage younger students to attend.

We write more about conference participation below in “Program Outcomes” and share our experiences in getting students to attend conferences with minimal financial resources in the “Get Involved” section.

2 Program Outcomes

2.1 CS/M Scholar Success

CS/M Scholars are excelling academically with an average GPA of over 3.4. Very few of them have fallen below, or even been close to the GPA requirement of 2.7 to continue in the program. A handful of students in the program
are involved in undergraduate research and one is pursuing an accelerated BS/MS program in computer science. Many CS/M Scholars who major in math are minoring in computer science. We attribute this to the experience of the first-year seminar in computer science as well as the stronger connections between students in the departments, built in part by this program.

Further, individual scholars have received national, regional or departmental recognition. For example, a CS/M Scholar was awarded a NOAA OED Hollings Scholarship in 2014. Others have been awarded merit-based state-wide or departmental scholarships. A scholar from the first cohort was chosen as her class’s speaker at commencement.

Furthermore, several scholars have participated in departmental clubs, community outreach and national or regional professional conferences. In one such case, students came back from the Nebraska Conference for Undergraduate Women in Mathematics and founded a club in our math department, the likes of which had not existed for many years.

2.2 Recruitment and Retention

Our recruitment efforts have become more successful as the program has grown which we attribute to the active involvement of current students in recruiting, a record of the program’s accomplishments, and a close partnership with WWU’s Office of Admissions.

The most effective recruiting event takes place at Western Preview. This is an annual campus-wide event in early April where potential first-year students who have been admitted (but have not yet confirmed) visit campus. Many of the interviews take place on this day. Since the second year of the program, current CS/M Scholars have voluntarily done a meet-and-greet with prospective students and their families. Many CS/M Scholars have identified the experience of meeting students in the program as the decisive factor in choosing to attend WWU and participate in the program. As the program has grown, student involvement with recruitment has increased as has our success in attracting students to the program. Last year, every applicant to the program who attended Western Preview decided to attend WWU.

All facets of the program after recruitment are designed to encourage retention. These include early and ongoing faculty advising, priority registration, the creation and preservation of a learning community both within a cohort and between the cohorts, exposure to research and career opportunities in these fields and integration of the students into the cultures of the
departments and the larger communities of the disciplines.

While we certainly do not expect all students who begin the program to graduate with a computer science or math degree, retention rates have exceeded our expectations. 79% of CS/M Scholars in cohorts 1-4 are either still in the program or have successfully completed a degree in math or computer science. For cohorts 2-4, this percentage is 86%, and for cohorts 2-5 it is 90% (cohort 5 is currently halfway through their first year). We attribute the rising retention rates to more effective recruiting, the greater sense of community in the program as it has grown and a record of success of the CS/M Scholars themselves.

2.3 Graduation and Time-to-Degree

All current CS/M Scholars are on track to complete a math or computer science degree in four years or less. Nine CS/M Scholars graduated as of June 2015 and all are working in a computer science or math-related field. Thus far, the average time-to-degree for a CS/M Scholar is 3.6 years, which compares favorably to the average time-to-degree for both math majors (4.4 years) and computer science majors (4.5 years) at WWU. The only CS/M Scholars who did not complete their undergraduate study in four years or less pursued double majors, but completed their math or computer science degree in four years or less.

2.4 Broader Impacts

All of the above has led to the scholars becoming visible, successful female members of male-dominated departments. In turn, their success has encouraged other female students to participate and persist in studying math and computer science.

While some of the effects of this program are qualitative in nature, such as improved department climate, we are beginning to see quantitative effects of the program on the overall demographics. For instance, in computer science, over the last six months we have been seeing that females are accounting for about 20% of our new majors. As a comparison, 10% of the graduates five years ago were female. Also, to be perfectly clear, the number of CS/M Scholars account for about 1% of the computer science department majors as a whole. So this growth by 10% in computer science is not directly related to the scholars program but is the result of a snowball effect. As more
women decide to major in computer science it is encouraging other women
to participate. While we are pleased with this growth we ultimately want to
shift the demographics of our graduates which has yet to happen.

Below in “Next Steps” we discuss our work toward furthering the breadth
of impact of this program.

3 How To Get Involved

Our efforts on this front started long before we applied for the NSF S-STEM
grant. The PI has been the faculty advisor to the department’s women in
computing club for more than 8 years. The women in computing club has
been an instrumental force in the computer science department in providing
a support network for women in the department. The math department has
had a calculus sequence for high-achieving students for years which included
targeted recruiting efforts. MORE HERE DAVID!

That being said, the NSF S-STEM grant served as a catalyst for change
because it raised the profile of some of the work we were already doing and
allowed us to enhance that work in a substantial way by offering scholarships
and performing more targeted recruiting. Interestingly, when we surveyed
the CS/M Scholars a couple years ago we asked them to rank the “features”
of the program and they said that scholarship money was highly important at
first but once they were here they ranked scholarship money at the bottom of
the list. Instead they valued the monthly get-togethers, the seminar classes,
and the community that developed all more than the scholarship money.
This survey served to show us that there are many impactful things that
we’ve done before and during the grant that others can do to increase the
participation of women which require few resources. We list some of these
examples below.

• Talk to women in your department and assess the climate. Ask a social
  scientist or a person in your equal opportunity office to facilitate a
discussion with female students with no departmental faculty members
there. Have that person write an executive summary and share that
with faculty. Have the faculty brainstorm ways to address issues that
came up in the climate assessment.

• Get the female students in your department organized into a club. A
  faculty member can initiate this but the getting students interested
and instilling in them a sense of ownership can really help create a positive climate in the department. Encourage club officers to turn over leadership of the club before they graduate so new students can lean on experienced students while they are learning the ropes. This approach helps keep the club active and engaged.

- Bring in female alumnae and professionals. Many departments bring in external speakers. Commit to bringing in women more regularly. Further, if those women are alumnae they have a unique capability of relating to current students. Moreover, our alumnae have been extremely willing to participate in such events and we imagine that other universities will experience the same. Beyond giving a talk, ask visitors to be part of a career panel or attend a lunch or dinner with female students. Connecting at this level can go a long way to motivating current students and getting them further engaged.

- Find ways to get female students to attend conferences. Many conferences such as the Nebraska Conference for Undergraduate Women in Mathematics, the Grace Hopper Celebration of Women in Computing, and the Women in Cyber Security Conference offer funding for attendance in part or in full. Also keep an eye out for regional events. In the Pacific Northwest we have sent students to the Northwest Regional Women in Computing workshop that was sponsored by Intel. A couple years ago the University of British Columbia held a “regional Hopper” event that some of our students attended. These regional events were heavily subsidized and provided a very cost effective avenue for students to network with and learn from other women in the field. There have been several events in Seattle each year focused on encouraging women in technical fields.

- Run a seminar series for new students. Even if a school can’t afford to create and offer a dedicated first-year seminar class as we did, a semi-regular gathering focusing on applied computer science or math, especially those that showcase an application with social import can have a profound effect on recruitment and retention.

Even easier, there are many resources from the National Center for Women in Information Technology (NCWIT), for instance, that discuss how to include more relevant assignments into introductory curriculum to encourage the participation of women and minorities [Citation:
https://www.ncwit.org/resources/customcatalog/engage-students-meaningful-curriculum]. These sorts of efforts don’t require more resources than those already being expended to teach an introductory course.

- Encouragement goes a long way. Again, NCWIT has wonderful resources related to this [CITATION: https://www.ncwit.org/resources/top-10-ways-retain-students-computing/top-10-ways-retain-students-computing]. We have heard several examples over the years from women who pointed to a moment that kept them engaged. It was incredibly significant to them but a lot of these examples were small gestures of encouragement on the part of a faculty member or a peer. We encourage anyone interested in furthering their efforts on this front to join NCWIT’s Academic Alliance which is free and full of great resources. In turn, we hope this will encourage you to encourage others!

4 Next Steps

We have many efforts in the pipeline to continue working on this issue. WWU’s computer science department was just accepted into NCWIT’s Pacesetters program. This is a national program that aims to help both university and industry members advance towards their goals of increasing the representation of women. Participation in this program is already providing the computer science department with many ideas for improvement.

We have applied for a new NSF S-STEM grant. The new grant, if funded, will initiate a design and development project that will build off of the current CS/M Scholars Program which we see as a pilot project. In our new proposal we have budgeted resources for an educational researcher to help us evaluate the CS/M Scholars Program both quantitatively and qualitatively so that we can more fully understand the program’s strengths and weaknesses. Also, our new proposal aims to increase the size of the CS/M Scholars Program while also adding some more features to the program to promote student success. Specifically, we are planning to formally connect students from different cohorts through a peer mentoring program. Finally, the new proposal includes more funding for conference travel since that has been so impactful on the students and the departments.

There are many other efforts in our College of Science and Engineering focused on diversity and inclusion. Basically, we’re trying to mirror efforts
from this program across the college when appropriate and viable. The goal isn’t to poach female students from other majors but make sure every female who is interested in computer science or math feels that the departments are welcoming and supportive of their participation.

5 bibliography

first year seminars:

https://www.wesleyan.edu/reslife/faculty-academic-partners/The_Impact_of_First_Years.pdf