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Gender and the National Alliance for Doctoral Study in the Mathematical Sciences: The Changing Academic and Career Aspirations of Alliance Students

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The disproportionately low participation of women in science, technology, engineering, and mathematics (STEM) fields has made the career aspirations of mathematically talented students of interest to scholars of higher education. Because members of the National Alliance for Doctoral Study in the Mathematical Sciences (henceforth “the Alliance”) are recruited and encouraged to pursue mathematical careers and exposed, through their membership, to diverse mathematicians and math related careers, the question arises as to whether the aspiration differences between genders still exists for this population. In this study I use the results from a survey of past and present Alliance students to investigate the academic and career aspirations of mathematically talented students, paying particular attention to women.

Gender, Career Aspirations, and Persistence in STEM

Clewell and Campbell (2002) summarize many of the biological, cognitive, and social conditioning explanations given for the differing STEM participation of men and women. Some have proposed that women simply do not value quantitative work that does not have a social connection (Turner & Bowen, 1999; Wiswall & Zafar, 2012). Others have suggested that women who enter the male dominated field of mathematics fear

fulfilling the stereotype that women cannot do math as well as men and, through this fear, underperform (Steele, 1997; Steele, 1999). Although the validity of this theory has on women in math has been called into question (Stoet & Geary, 2012), the fact remains that mathematics is considered a “male” discipline in Western culture. Evidence for this cultural norm exists. For example, men are more likely than women to think they can perform quantitative tasks (Correll, 2001).

The values that guide major and career selection are difficult to pin down, as is how these aspirations and values are shaped. Women tend to value opportunities that allow them to engage in several activities at the same time more than men (Eccles, 1994). Hearn (1987) finds those who intended to earn a graduate degree were similar in terms of their grades, faculty interactions, and early aspirations, but men’s aspirations were directly affected by their satisfaction with their graduate department, while women’s aspirations were directly affected by parental support.

Mau (2003) finds that boys and girls who persist in STEM aspirations between eighth grade and the second year of college had higher academic proficiency, socio-economic status, math self-efficacy, and reading self-efficacy, but boys persist in STEM at twice the rate of girls. Sax (1994) found that the overall rate of per-



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sistence in STEM during college is similar for men and women but men and women had different reasons for ultimately opting out of STEM in college. The fact that the STEM opt-out rate is similar for men and women in college but the overall participation rate is not equal suggests that decisions about STEM aspirations are made earlier than college. Sax also notes that research experience with a faculty member leads to persistence for undergraduate women but does not show as significant for men.

Sample and Data Sources

An adaptive electronic survey was sent to all past and present Alliance students for whom the Alliance organizers had email addresses for. Respondents were first asked basic demographic information and then piped into different versions of the survey based on whether they were a student or not and, if they were a student, what degree they were pursuing. A total of 840 invitations were sent. Of those, 90 (10.7%) past and present Alliance students submitted complete responses and 46 (5.5%) submitted partial responses for an overall response rate of 16.2%. Not every participant answered every question the sample size for individual questions varies, so sample sizes are reported for each item discussed below.

Although the known gender composition of the Alliance is divided fairly evenly between men and women, more women responded than men. This participation pattern is common at the college level (Smith, 2008). Of the Alliance members who participated, about 12% were no longer students and the remainder of the respondents were evenly split between graduate and undergraduate

students. Table 1 gives the breakdown of the participants by gender and education status. The data examined in this study focuses on the student respondents.

Short and Long Term Aspirations

The survey included two check all that apply questions asked about the short term (three to five years out) and long term (more than five years out) aspirations. Students picked aspirations from: teaching, research, industry, academia, government, and further education. Around 40% of the survey participants choose three or more goals, suggesting a lack of overall focus in academic and career aspirations.

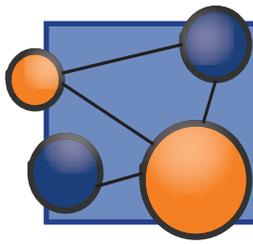
Men and women who selected two or fewer goals from the questions asking them to indicate their short and long term goals did not show much variation in their aspirations. Some of the tallies suggest a difference between men and women's aspirations could exist, but in most of these instances the cell sizes were too small to run reliable statistical tests to determine if these observed differences are significant. A copy of the table of tallies is in Issue Brief #5.

It was unexpected that so many participants picked three or more goals in both the short and long term. In addition, the percentage of women with three or more goals was always lower than that of the men in the sample. As a result, I ran a Chi-squared test on whether women were proportionally more likely to have two or fewer goals in both the short and long term. The short term goal test was insignificant, but women did have a significant test statistic on their long term goals. That is, women in this study are statistically more focused than their male counterparts when it comes to

Table 1. Gender and Educational Status of Survey Participants

	Undergraduate		Graduate		Not a student		Total	
	<i>n</i>	Percent	<i>n</i>	Percent	<i>n</i>	Percent	<i>n</i>	Percent
Male	19	(17.0)	19	(17.0)	7	(6.3)	45	(40.2)
Female	30	(26.8)	30	(26.8)	7	(6.3)	67	(59.8)
Total	49	(43.8)	49	(43.8)	14	(12.5)	112	





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Table 2. Focus Test Statistics for Chi-Square Comparison Between Genders

	Short term			Long term		
	Male	Female	<i>p</i> -value	Male	Female	<i>p</i> -value
Picked two or fewer goals	13	33	0.1283	6	27	0.0090*
Picked three or more goals	18	23		21	24	
	31	56		27	51	

*Significant at the 0.01 level.

long term goals. Table 2 presents the tallies and *p*-values of the test.

Some work hypothesizes that women show more interest in STEM careers that value human interaction and social improvement (Turner & Bowen, 1999; Wiswall & Zafar, 2012). Of the six career aspirations the students could select from teaching falls the most directly into this category. To see if some relationship existed between gender and the desire to teach, I ran a Chi-square test between the men and women who picked two or fewer goals and had selected teaching as a goal. The results from this test are not significant. Table 3 displays the results.

Change in Academic and Career Aspirations

On the electronic survey, the short answer questions asked student respondents how their academic and career plans have changed. The responses to these questions were read, a coding scheme developed, and then each response was assigned a code. I then tallied the responses and examined the tallies for patterns by gender and educational status.

Most participants indicated that no change had occurred in either their academic or career aspirations. This was particularly true of the graduate student survey

participants. Undergraduates who indicated they had made some change in their academic plans tended to change towards mathematics or change their degree aspirations to a higher level than they had previously aspired to. Given that Alliance membership is related to a desire to pursue mathematics after a bachelors has been earned, this trend makes sense. It was also common for both undergraduates and graduate students to change focus within the mathematical sciences but not change their degree or general interest in the mathematical sciences.

Graduate students who changed their academic plans generally had decided to earn a higher degree. A small handful demonstrated movement away from the mathematical sciences but their movement was still within STEM. This was true of both academic and career goals. Women did have more movement away from math towards STEM than men, but the cell sizes were too small to run a significance test. Table 4 shows the tallies for each of the change types noted in the responses.

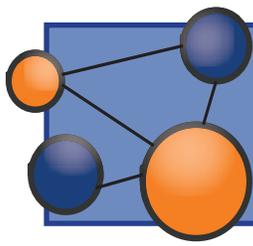
Conclusions

Some might say that efforts to promote female participation in the mathematical sciences ignores the fact that women select out of these fields and choose instead to pursue STEM based fields that value more

Table 3. Teaching Goal Test Statistics for Chi-Square Comparison Between Genders

	Short term			Long term		
	Male	Female	<i>p</i> -value	Male	Female	<i>p</i> -value
Teaching is a goal	5	10	0.5612	1	6	0.1490
Teaching is not a goal	40	57		44	61	
	45	67		45	67	





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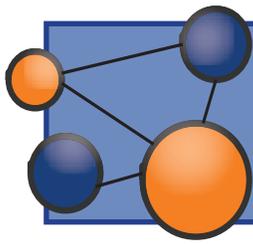
Table 4. *Changes in Academic and Career Aspirations by Gender and Educational Status*

Description of Change		Male		Female	
		Graduate	Undergraduate	Graduate	Undergraduate
Academic Aspirations					
Changed towards STEM	Towards math	0	3	1	6
	Towards STEM	1	0	0	1
Changed away from math	Towards STEM	2	0	2	0
	Towards non-STEM	1	0	0	0
Changed focus	Within STEM	0	0	1	0
	Within math	0	3	0	2
Changed degree plans	To higher degree	3	3	1	5
	To lower degree	1	0	2	0
Gained Confidence		0	0	1	0
Became more focused		0	2	1	5
Timeline changed		0	0	1	1
No change		8	2	16	3
Response does not make sense		1	2	1	2
Career Aspirations					
Changed focus within math		0	7	5	2
Changed towards math	From non-math	0	0	0	0
	From STEM	0	2	1	5
Changed away from math		0	0	2	1
Changed from non-STEM to STEM		0	0	0	1
Gained Confidence		2	0	1	0
Still Learning		0	1	0	2
No change		9	4	19	7
Response does not make sense		2	0	0	5

social interaction than the mathematical sciences traditionally do, but the women in this study were talented and interested in mathematical careers of all types. The Alliance has fairly equal representation of male and female students and both men and women were interested in the careers the Alliance promotes, suggesting that if

the interest is cultivated and supported through difficult transitions, women will stay in the mathematical sciences and set ambitious goals for themselves within these fields. These findings lend support to the importance of efforts that seek to increase female participation and maintain female and other minority students in math-





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emathical science programs. A diverse mathematical community is possible with the proper support.

Note: A more detailed version of this paper is available from the author upon request. Please email mmakows2@illinois.edu if you would like a copy of the complete manuscript.

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Martha Makowski, MS, is a graduate research assistant in Curriculum and Instruction at the University of Illinois at Urbana-Champaign. She earned her Masters in Mathematics in 2007 and then taught mathematics at a community college for five years. She is interested in adult learners of mathematics, preparing mathematics teachers, and equity in STEM.

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