Math Alliance Research Study

Issue Brief #5
January 2014

Math Alliance Research Study: Descriptive Statistics and Initial Findings from the Student Survey

Martha Makowski, Lisa Dobson
Blanca Rincon & Casey George-Jackson

The Math Alliance Research Study (MARS) is currently investigating the structures of the National Alliance for Doctoral Studies in the Mathematical Sciences (hereafter, "the Alliance") that promote success in diversifying the mathematical sciences and whether these structures are replicable to other disciplines . Data collection, which began in August 2013 and will continue through the summer of 2014, includes surveys, campus visits, focus groups, interviews, and observations at the Alliance's annual Field of Dreams conference. This brief introduces the basic design and purpose of the student survey, reports basic demographics of the participating students, and highlights initial findings that will be investigated further in future work by the MARS team.

Student Survey Purpose and Design

In its brief tenure, the Alliance has served close to 1000 students, making students the largest group of stakeholders in the Alliance. One goal of the Alliance is to promote student success in the mathematical sciences, meaning the experiences and goals of students during and following their participation in the Alliance are important to know about and understand. In order to systematically collect such information, an online survey was administered to both current and former Alliance participants during Fall 2013.

With the above in mind, the MARS team developed an adaptive electronic survey that was sent to all Alliance students, past or present. Students were first asked basic demographic information and then piped into different versions of the survey based on whether they were currently enrolled and, if they were a student, whether they were pursuing an undergraduate or graduate degree. Questions varied in format, but included multiple choice, short answer, and free response questions. The length of the survey varied depending on the number of Alliance related activities the survey participant had engaged in, with students who were more involved answering more questions. Respondents who completed the survey were entered into a drawing for one of seven prizes, valued between $50 and $200.

The survey was launched at the beginning of September 2013 and remained open through the second week of November 2013. Eight hundred and forty current and former Alliance participants were invited to participate via email. 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%. Because not every participant answered every question the sample size for individual questions varies, so sample sizes are reported for each item discussed below.

Student Survey Participants

Of the Alliance members who participated, about 12% were no longer students and the remainder of the respondents were split evenly between graduate and undergraduate students (Table 1). Although the known gender composition of the Alliance is divided fairly evenly between men and women, more women responded then men (Table 2).

Table 1. *Gender of Survey Participants*

	n	Percent
Female	67	59.8
Male	45	40.2
Total	112	

Table 2. *Educational Status of Survey Participants*

	n	Percent
Undergraduate student	49	43.8
Graduate student	49	43.8
Not currently a student	14	12.5
Total	112	

Students were given the option to self-select more than one racial or ethnic category. The 112 participants who answered the race and ethnicity questions came from a variety of racial and ethnic backgrounds, but most self-selected as either Latino/White (25) or Black (33). Table 3 summarizes the data on race of the participants.

Table 3. *Race/Ethnicity of Survey Participants*

Race	*n*	Percent
White	11	7.9
Latino	7	5.0
Latino/White	25	18.0
Latino/non-White	17	12.2
Black	33	23.7
African/Caribbean	2	1.4
Asian/Pacific Islander	6	4.3
Other race	1	0.7
More than one category selected	10	7.2
No race selected	27	19.4
Total	139	

Student Survey Preliminary Results

The following four sections each introduce one area of exploration underway by the MARS research team. Each introduction highlights the issue under study and the rationale for its investigation within the context of the Alliance and summarizes some initial findings. These issues will be explored in greater detail in later research briefs.

Mathematical Identity. The importance of science identity has been well documented as a factor of persistence in the Science, Technology, Engineering, and Mathematics (STEM) fields during college (Chang, Eagan, Lin & Hurtado, 2011), as well as entering STEM-related careers (Carlone & Johnson, 2007). Within this literature, a number of studies have found significant differences between men and women's science identities (Archer, DeWitt, Osborne, Dillon, Willis & Wong, 2010; Barndura, Barbarnelli, Caprara & Pastorelli, 2001; Williams and George-Jackson, in press). However, little empirical work has been done to investigate the importance of math identity and the extent to which students may self-identify as a mathematician or statistician. Nosek, Banaji, and Greenwald (2002) found that women were more likely to associate math with being male rather than with themselves, even among women who were enrolled in math-based majors. This study suggests that similar to science identity, there may be important gender differences within students' self-identification with math.

To expand current understandings of math identity, the survey asked students if they identified as: 1) a mathematician; 2) a statistician; 3) neither a mathematician nor statistician; or 4) self-identified in another way. Table 4 summarizes how students responded to this question, by gender.

Preliminary results suggest that a greater percentage of women strongly agree that they are comfortable identifying as a mathematician and that their department provides opportunities for them to develop their math identity. Interestingly, a greater percentage of men strongly agree that it is important for others to see them as a mathematician. The majority of both men and women indicate that doing math is important to who they are, that they enjoy solving problems, and that math will allow them to help others. This line of research is expected to allow for further understanding of math identity in general, as well as specific aspects of identity such as how students see themselves, how they perceive others to see them, and how they intend to use math.

Influences on the Intent to Pursue Mathematics. In order to increase participation of traditionally underrepresented populations

Table 4. *Self-Identity of Current Students by Gender*

	Mathematician		Statistician		Neither		Other		
	n	Percent	*n*	Percent	*n*	Percent	*n*	Percent	Total
Male	20	(69.0)	2	(6.9)	3	(10.3)	4	(13.8)	29
Female	36	(65.5)	6	(10.9)	9	(16.4)	4	(7.3)	55
Total	56	(66.7)	8	(9.5)	12	(14.3)	8	(9.5)	84

in the mathematical sciences, it is critical to understand what influences students of these populations to pursue mathematical degrees. Understanding what impacts students' degree choices allow for meaningful, appropriate programs to be developed. Previous work in this area examines only few specific groups (Hackett, Betz, Casas, & Rocha-Singh, 1992), surveys all college majors (Gainor & Lent, 1998; Lent et al., 2001; Luzzo et al., 1999), or investigates career intentions of pre-college students (Garriott, Flores, & Martens, 2013). Data collected from the student survey of current and former Alliance students can shed new light on these influences for diverse mathematically talented individuals. By investigating responses related to career choice gathered in data collection, a greater insight may be gained about what factors influence traditionally underrepresented populations to pursue a degree in mathematical sciences.

Respondents were asked, "What influenced you to pursue a degree in math?" with the option to check all that apply from the following choices: good at math, career opportunities after graduation, interest in solving problems, enjoys math courses, recommended by an academic advisor, recommended by a faculty member, recommended by family or friends, or other. Figure 1 presents the raw tallies and percentages of respondents who selected each choice, disaggregated by gender. Initial analysis shows that more female respondents were influenced by being "good at math", while more male respondents were influenced by recommendations from academic advisors, faculty members, family, or friends. A greater percentage of men indicated that their decision was influenced by potential career opportunities available after graduation, as compared to women.

In an upcoming brief, we will investigate these

Figure 1. *Influences on Math Trajectory by Gender*

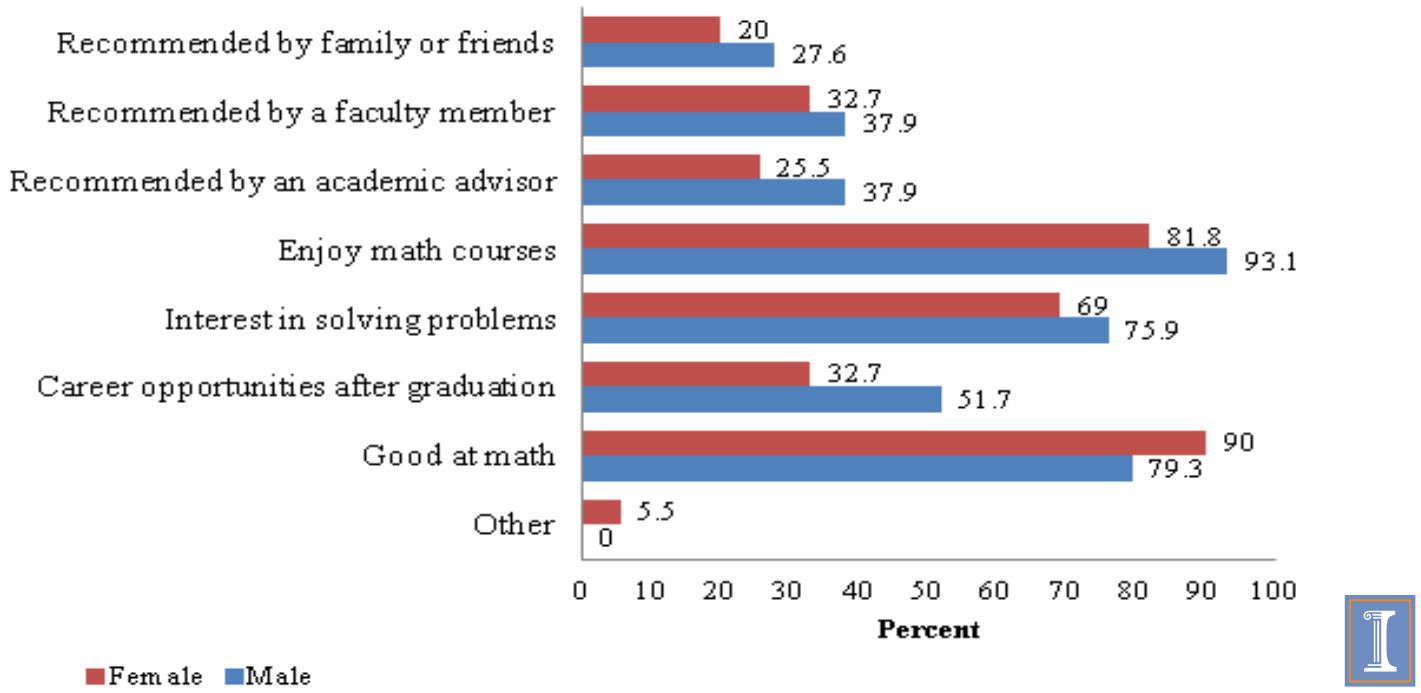


Table 5. *Short and Long Term Goals by Gender*

	Short Term				Long Term			
	Male		Female		Male		Female	
Aspiration	*n*	Percent	*n*	Percent	*n*	Percent	*n*	Percent
Teaching only	1	(3.0)	3	(4.5)	1	(3.7)	3	(5.8)
Research only	0	(0.0)	3	(4.5)	0	(0.0)	1	(1.9)
Industry only	0	(0.0)	3	(4.5)	0	(0.0)	2	(3.8)
Academia only	0	(0.0)	2	(3.0)	0	(0.0)	2	(3.8)
Government only	0	(0.0)	2	(3.0)	0	(0.0)	1	(1.9)
Further education only	3	(9.1)	8	(12.1)	1	(3.7)	2	(3.8)
Teaching & Research only	1	(3.0)	2	(3.0)	0	(0.0)	1	(1.9)
Teaching & Academia only	1	(3.0)	2	(3.0)	0	(0.0)	1	(1.9)
Teaching & further education only	1	(3.0)	1	(1.5)	0	(0.0)	1	(1.9)
Research & Industry only	2	(6.1)	6	(9.1)	1	(3.7)	5	(9.6)
Research & Academia only	2	(6.1)	3	(4.5)	1	(3.7)	3	(5.8)
Research & government only	1	(3.0)	1	(1.5)	1	(3.7)	1	(1.9)
Research & further education only	1	(3.0)	2	(3.0)	0	(0.0)	0	(0.0)
Industry & Academia only	0	(0.0)	2	(3.0)	0	(0.0)	2	(3.8)
Industry & government only	0	(0.0)	1	(1.5)	0	(0.0)	1	(1.9)
Academia & government only	0	(0.0)	1	(1.5)	0	(0.0)	1	(1.9)
Academia & further education only	1	(3.0)	0	(0.0)	1	(3.7)	0	(0.0)
Government & further education only	1	(3.0)	0	(0.0)	0	(0.0)	0	(0.0)
More than 2 goals selected	18	(54.5)	24	(36.4)	21	(77.8)	25	(48.1)
Total	33		66		27		52	

responses in relation to gender, degree program, mathematical sciences sub-field, race/ethnicity, and academic year. This data will be contrasted with information about degree choice collected during student focus groups and other data gleaned from the overall research project.

Academic and Career Aspirations. Attempts to improve the representation of different groups in STEM fields generally must overcome the damage done by stereotypes that suggest women and students of color are not as good at math and science as white men. These stereotypes, often internalized and unconscious (Steele, 1997), have an impact on the aspirations of minority and female students towards careers in STEM fields. For example, Correll (2004) finds that college aged men who demonstrate competence in a new quantitative task form higher career aspirations related to the task than women performing at the same level. The effect Correll notices becomes stronger when the women are lead to believe that men generally perform better on the task than women. The Alliance offers an opportunity to examine the aspirations of mathematically talented students from minority backgrounds to determine if certain factors are associated with a change in aspirations to earn advanced degrees in mathematics or pursue mathematical careers. The qualitative description of the aspirations can also be examined to determine if different student populations tend towards different types of mathematical careers with different value sets.

The student survey asked students about their short and long term goals, with options that included teaching, research, industry, academia, government, and continuing their education. Participants were asked to select as many of the goals they aspired to in the short term (3-5 years out) and the long term (greater than 5

years out). Table 5 presents the goals indicated for students who were focused in their goals (indicated by two or fewer aspirations). The most striking contrast seems to be that the women are more focused in their careers aspirations than their male counterparts, with only 36% of women selecting three or more short term goals, compared to 54% of men. A similar result is apparent for the long term goals (48% compared to 78%).

Current students were also asked about whether their academic and career aspirations had changed during the course of their academic program and, if so, what had lead to the change. Initial analysis of these data suggest that many students have not changed their aspirations for a degree or future career during their current program, but those that have changed have a variety of types of changes and reasons for those changes. A future brief will classify the types of changes made and compare these changes between gender and class status.

The Climate of Math. The unwelcoming climate experienced by female students pursuing traditionally male dominated careers (Rankin & Reason, 2005; Tate & Linn, 2005) and racial minorities attending Predominantly White Institutions has been well documented (Milem et. al., 1998; Palmer et al., 2011). Often invisible to white and male students, females and students of color are more likely to report encountering racism and sexism at the university (Rankin and Reason, 2005). The atmosphere created by discriminatory practices, policies, and behaviors have been linked to academic outcomes such as attrition (Nora & Cabrera, 1996; Rankin & Reason, 2005). Math and science departments offer an added layer of complexity given their lack of diversity and competitive culture (Palmer et al., 2011).

In order to understand the disciplinary climate experienced by Alliance students in mathematical science departments across the country, the student survey asked about department support for underrepresented students and whether the student had experienced discrimination within their department. Preliminary analysis of the MARS student survey data finds that one in five students believe that the climate of their department fails to support traditionally underrepresented students. Table 6 shows that of the seventy-four respondents,

Table 6. *Place and Type of Discrimination Experienced*

	In Department		On the basis of Gender		On the basis of Race	
	n	Percent	*n*	Percent	*n*	Percent
Yes	16	(21.6)	8	(10.8)	6	(8.1)
No	58	(78.4)	66	(89.2)	68	(91.9)
Total	74		74		74	

21.6% reported personally experiencing some form of discrimination within their department, including discrimination on the basis of their sexual orientation, race, gender, and age.

An upcoming research brief will examine the climate of mathematical sciences departments and the discrimination within them as experienced and perceived by Alliance participants, by examining the survey responses by race, postsecondary degree, and institutional type (including whether a department is a member of the Alliance).

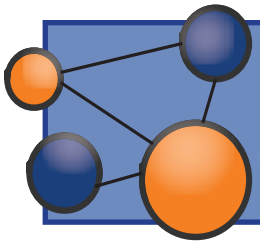
Summary

The work highlighted above represents a small fraction of the questions that can be examined using the student survey data and the analysis in its present form poses more questions than it answers. Future briefs using this data will consider these topics in further detail, including how responses and explorations vary by gender, race, and student type categories. The initial findings presented here suggest that despite some experiences with discrimination within their departments, the Alliance student population sets high expectations for themselves, identify as members of the mathematical science community, and are positively influenced by faculty and academic mentors.

References

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., and Wong, B. (2010). "Doing" science versus "being" a scientist: Examining 10/11-year-old schoolchildren's constructions of science through the lens of identity. *Science Education, 94*(4), 617–639.

Bandura, A., Barbaranelli, C., Caprara, G. V., and Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. *Child Development, 72*(1), 187–206.



Math Alliance Research Study

Carlone, H. B. and Johnson, A. C., (2007). Understanding the science experiences of women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*(8), 1187–1218.

Chang, M. J., Eagan, M. K., Lin, M. H., & Hurtado, S., (2011). Considering the impact of racial stigmas and science identity: Persistence among biomedical and behavioral science aspirants. *Journal of High Education, 82*(5), 564–596.

Correll, S. J. (2004). Constraints into preferences: Gender, status, and emerging career aspirations. *American Sociological Review, 69*(1), 93-113.

Gainor, K. A., & Lent, R. W. (1998). Social cognitive expectations and racial identity attitudes in predicting the math choice intentions of Black college students. *Journal of Counseling Psychology, 45*, 403-413.

Garriott, P. O., Flores, L. Y., & Martens, M. P. (2013). Predicting the math/science career goals of low-income prospective first-generation college students. *Journal of Counseling Psychology, 60*, 200-209.

Hackett, G., Betz, N. E., Casas, J. M., & Rocha-Singh, I. A. (1992). Gender, ethnicity, and social cognitive factors predicting the academic achievement of students in engineering. *Journal of Counseling Psychology, 39*, 527-538.

Lent, R. W., Brown, S. D., Brenner, B., Chopra, S. B., Davis, T., Talleyrand, R., & Suthakaran, V. (2001). The role of contextual supports and barriers in the choice of math/science educational options: A test of social cognitive hypotheses. *Journal of Counseling Psychology, 48*, 474-483.

Luzzo, D. A., Hasper, P., Albert, K. A., Bibby, M. A., & Martinelli, E. A., Jr. (1999). Effects of self-efficacy-enhancing interventions on the math/science self-efficacy and career interests, goals, and actions of career undecided college students. *Journal of Counseling Psychology, 46*, 233-243.

Milem, J. F., Clayton-Pedersen, A. R., Hurtado, S., & Allen, W. R. (1998). Enhancing campus climates for racial/ethnic diversity: Educational policy and practice. *The Review of Higher Education, 21*(3), 279-302.

This material is based upon work supported by the National Science Foundation under Grant No. 1242941 to the University of Illinois at Urbana-Champaign. 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.

Nora, A. & Cabrera, A. F. (1996). The role of perceptions of prejudice and discrimination on the adjustment to college. *Journal of Higher Education, 67*(2), 119-148.

Nosek, B.A., Banaji, M.R., & Greenwald, A.G. (2002). Math = male, me = female, therefore math ≠ me. *Journal of Personality and Social Psychology, 83*(1), 44–59.

Palmer, P., Maramba, P., & Dancy, P. (2011). A qualitative investigation of factors promoting the retention and persistence of students of color in STEM. *Journal of Negro Education., 80*(4), 491–504.

Rankin, S. R., & Reason, R. D. (2005). Differing perceptions: How students of color and white students perceive campus climate for underrepresented groups. *Journal of College Student Development, 46*(1), 43-61.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*(6), 613-629.

Tate, E. D., & Linn, M. C. (2005). How does identity shape the experiences of women of color engineering students?. *Journal of Science Education and Technology, 14*(5-6), 483-493.

Williams, M.M. & George-Jackson, C.E., (in press). Using and doing science: Gender, self-efficacy, and science identity of undergraduate students in STEM. *Journal of Women and Minorities in Science and Engineering.*

About the Authors

Martha Makowski is a doctoral student in Curriculum and Instruction at the University of Illinois at Urbana-Champaign. Lisa Dobson is a graduate student in Curriculum and Instruction at the University of Illinois at Urbana-Champaign. Blanca Rincon is a doctoral student in the Department of Education Policy, Organization and Leadership at the University of Illinois at Urbana-Champaign. Dr. Casey George-Jackson is the Principal Investigator of the Math Alliance Research Study and is an Institute of Education Sciences Postdoctoral Research Fellow in Mathematics Education.