

# **“So I’ve Chosen to Major in Math. Now What?”: Mathematics Students’ Knowledge of Future Career Options**

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*Research suggests that many mathematics students leave the field of mathematics either during their undergraduate career or shortly after earning a bachelor’s degree in mathematics (Seymour & Hewitt, 1997). Furthermore, preliminary work by the author of this paper suggests that many undergraduate mathematics majors view their degree as “limiting” and do not believe it opens them up to many career options. In this study we investigated what careers graduating mathematics majors believe are available to them with a bachelor’s degree in mathematics, how they learned about their career options, and what they plan to do upon graduation. We also investigated what influenced these students to choose to earn a degree in mathematics. Such information may be useful for informing the mathematics community on ways to recruit and retain mathematics students.*

## **Introduction:**

Substantial research has been conducted to determine what influences college students’ choice of major and what causes individuals to select certain careers. Some of the reasons present in the literature are interest, aptitude, opportunities for career advancement and earning potential, family pressure, and the pedagogy of the discipline (Jacobs, 2005; Malgwi, Howe, & Burnaby, 2005; Morgan, Isaac, & Sansone, 2001; Sax & Bryant, 2006; Trautwein & Ludtke, 2006). Although no study has directly addressed this topic for the discipline of mathematics, research

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<sup>1</sup> Conception of this project and part of the data collection was done in conjunction with: Tim Gutmann, University of New England, 1966 – 2007.

suggests that many undergraduate mathematics majors may be unaware of what types of job opportunities are available to them once they graduate with a bachelor's degree in mathematics (Leitze, 1996; Stage & Maple, 1996). Furthermore, many math majors view their degree as "limiting" with respect to career options (Linn & Kessel, 1996; Piatek-Jimenez, in preparation).

The purpose of this study was to investigate what career options senior mathematics majors believe are available to them with a bachelor's degree in mathematics, how they learned about their career options, and what they plan to do professionally upon graduation. We also investigated what influenced these students to choose to earn a degree in mathematics.

### **Method:**

The participants for this study were 32 undergraduate mathematics majors at a large public university in the Midwest. All of the participants had senior class-standing and planned to graduate within one year of the study. Half of the participants (16 out of 32) were enrolled in a capstone course for mathematics majors. This course is designed to cover important mathematical content not traditionally covered in undergraduate coursework and to help students make connections between different sub-disciplines of mathematics. The course is also intended to help introduce the students to the culture of the mathematics community and to inform them of different mathematical organizations, such as the MAA and AMS. All mathematics majors at this university who are not earning a degree for high school teaching are required to take this course. The other half of the participants in the study were students enrolled in a mathematics teaching methods course required for all mathematics majors earning a teaching degree. This course was designed to provide prospective teachers with knowledge and teaching techniques necessary for teaching mathematics at the secondary school level.

The survey was given to the students in both of these courses at the end of the spring semester of 2007. In the capstone course, completing the questionnaire counted as part of one assignment in the course. In the methods course, completing the questionnaire was an option to satisfy an assignment for the class. As a result, we received approximately a 90% return rate on the surveys.

The written responses on the surveys were then analyzed with respect to our research questions. We analyzed the responses both as a whole and with respect to the course in which the students were enrolled.

### **Results:**

Amongst the 32 participants in the study, 20 different careers were mentioned as available to someone with a bachelor's degree in mathematics. Each individual participant was able to list between 0 and 8 careers, with the median number of careers listed being 3. Although the variety of careers mentioned between the two courses were similar, each individual student in the capstone course was able to list more careers, on average. The average number of careers the capstone students listed was 3.8, while the average number of careers listed by the methods students was 2.6. The types of careers listed by the students in the capstone course and the students in the methods course also varied. The top three careers mentioned by the capstone students were actuary/insurance/ underwriter (9), statistician (8), and teacher (7). The top three careers mentioned by the methods students were teacher (14), engineer (5), and government/national security/cryptography (4).

Although these students were able to list a variety of careers, some of their responses demonstrated a shallow understanding of the careers and posed doubt whether or not these careers were valid options:

A relative said that the government looks for people with math degrees to break codes. Other than that I don't know. (capstone student)

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I honestly don't know. I listed some possible career choices on the front of this page, but I don't know for sure if a BS in Mathematics is sufficient. (capstone student)

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The government, I don't know exactly what the positions are but I heard from a friend who has a relative in that area. Lots of companies, such as insurance and accounting firms, are looking for people with analytical skills from math majors, from what I hear during career fair events. (capstone student)

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People with a bachelor's degree in math can be teachers. That is all I really know of unless they get further education like their Masters or PHD. (methods student)

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Banking, but really not sure! (methods student)

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Mathematician...do they even exist anymore? (methods student)

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These comments from the participants seem to suggest that although these students have heard that such job opportunities exist, they really are not sure what these jobs entail or how to go about entering such careers.

In addition to knowing which careers these students were aware of, we were also interested to know where they had learned about each of these careers. Despite asking the

participants for this information, very few of them provided it. This may have occurred for a couple of reasons. One possibility is that the participants did not remember where they had learned about a career. Alternatively, they may have felt like it was not relevant, as in the case of a “teacher”, for example. Finally, it is possible the participant simply forgot to include this information because the survey question was written with two parts (what careers and where they learn about them). Of the participants that did include this information, the sources mentioned (and the number of people who mentioned each) were: internet (3), friend/relative (2), career test (1), career fair (1), a college professor (1), and “read somewhere” (1). One of the participants specifically wrote that she had visited career services to try to learn about more career options, but claimed the services in that office were not very helpful. The fact that these students had been searching the internet and attending career fairs and career services to learn more about possible employment options suggests that these students were actively searching for possible careers that would utilize their mathematics degree.

As may be expected, we found that the students in the teaching methods class were fairly certain of their career path after graduation. Thirteen of the 16 participants in this class intended to find a job as a high school or middle school mathematics teacher. Of the other three participants in this class, one had plans to become an athletics administrator, one will be entering a Ph.D. program in mathematics education, and the last participant intended to become a pharmaceutical representative. The students in the capstone course, however, had a much larger variety of plans for their futures. Two of the students who were double majoring in mathematics and actuarial science had plans to become actuaries. Another participant will be joining the Peace Corps after graduation. Some of the students in the capstone course also had aspirations

for the teaching profession. Two of them intend to teach middle or high school and two would like to eventually teach at a community college.

One notable difference between the students in the capstone course and those in the methods course is that a larger number of the students in the capstone course were planning on attending graduate school. Interestingly enough, however, of the seven capstone students who were planning to attend graduate school, only three planned to continue in mathematics. Of the remaining four, one planned to go to chiropractic school, one was accepted into a doctoral program in chemical engineering, one was entering a program to earn an M.S. in Finance, and the last student wanted to earn a graduate certificate in data mining.

Also quite notable was the fact that one-fourth of the capstone students had no idea what they planned to do professionally after graduation. These students candidly wrote:

Hopefully find a good paying job in [state]. I'm not sure in what though.  
(capstone student)

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Get a good job where I can put my degree to good use. (capstone student)

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I honestly don't know... Basically, I plan on sending my resume out to as many prospective employers as possible. (capstone student)

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Spend some time with family, travel throughout Europe for several weeks, then figure things out from there. Maybe volunteer work. (capstone student)

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It is important to note that each of these students were planning to graduate in less than one year from the time of completing the surveys.

In addition to learning about mathematics majors' knowledge of careers in mathematics and their future professional plans, we also investigated what influenced these students' decision to major in mathematics. By far, the reason that was most frequently mentioned was their enjoyment and/or interest in mathematics, which was provided by 21 of the 32 participants in the study. The second most common reason, stated by nine of the 32 participants, was their belief of themselves to be good at mathematics. Five of the students claimed that they chose to major in mathematics because mathematics was a suitable double-major with a different major they had previously chosen. Four students credited their choice of major to the positive influence of a high school mathematics teacher.<sup>2</sup> Each of the other reasons that were referenced were only mentioned by one or two participants. These included: mathematics is challenging, having family members with mathematics careers, peers/friends, it is a marketable degree (for high school teaching), the influence of college mathematics classes, lack of a better major, and it was the degree that would allow that student to graduate at that point in the shortest amount of time.

Another result we found to be interesting was the difference of *when* the methods students and the capstone students chose to major in mathematics. Of the 16 students in the methods course, eight of them had decided to major in mathematics during high school or earlier. Another six of these students made this decision as freshmen in college. On the other hand, the capstone students decided upon a mathematics degree much later in their educational careers. Only three of the 16 capstone students chose to major in mathematics sometime in high school or earlier and only another two had made this decision while they were freshmen in college. The

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<sup>2</sup> Each of these participants were in the methods course and were intending to become teachers themselves.

other 11 capstone students decided to major in mathematics at a later point in college. Therefore, it appears that mathematics students who decide to go into teaching make career decisions at a much earlier stage in life than those who do not. This, actually, may not be all that surprising. As has been noted by the National Center for Educational Statistics (NCES), only some college majors prepare students for specific career paths. The NCES refers to these as “career areas”<sup>3</sup> while all other degrees are referred to as “academic areas” (NCES, 2005). A degree in mathematics, unless intended for teaching purposes, would be considered a degree in an “academic area”. It seems to us that it is logical that individuals who choose to enter “career areas” would do so earlier in life than those who enter “academic areas” because there is a specific occupation associated with such a choice. Although there is no substantial research in this area, McHarg, Mattick, and Knight (2007) similarly found that students who enter medical school, another “career area”, had made the choice to study medicine at a young age. More research should be conducted to verify this hypothesis.

### **Discussion:**

Presently, there is a national concern that not enough people are entering the workforce in the STEM (Science, Technology, Engineering, and Mathematics) fields. Furthermore, many students who major in mathematics do not enter mathematics careers. So one may wonder: where are these students going? If these students, for example, are earning degrees in mathematics but are entering careers in other STEM disciplines, then they may not truly be leaving the field of mathematics but are simply finding means to apply their mathematical

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<sup>3</sup> The 11 “career areas”, as defined by the NCES, are: 1) agriculture/natural resources, 2) business/marketing, 3) computer science, 4) communications/design, 5) consumer and personal services, 6) education, 7) engineering/architectural sciences, 8) health care, 9) protective services, 10) public, social, and human services, and 11) trade and industry.

knowledge. If these students, on the other hand, are leaving the STEM disciplines altogether, then we are losing many talented minds from contributing to these fields.

From the small sample of participants in this study, we cannot make any hypotheses as to which fields mathematics graduates enter. In 2003, however, a survey titled, “National Survey of Recent College Graduates” was conducted by Mathematica Policy Research Inc. for the National Science Foundation (NSF) to investigate the career decisions made by recent STEM graduates. The target population for this survey was all individuals who received a S&E (Science and Engineering) bachelor’s degree from a U.S. institution in 2001 and 2002, lived in the U.S. when the survey was conducted, and was under the age of 76. Even though the data collection for the surveys spanned over a period of months, in order to retain consistency, all participants were asked to respond to the survey with respect to their employment during the week of October 1<sup>st</sup>, 2003. The technical notes of the report describe the sample design and the accuracy of estimates for the results stated in the report (NSF, 2003).

In the “Characteristics of Recent Science and Engineering Graduates: 2003” report (NSF, 2006), it is noted that there were 25,600 graduates with a bachelor’s degree in mathematics or statistics during the years 2001 and 2002. Of those 25,600 graduates, 23,200 were considered members of the labor force. To be included within this category, the graduate must have either been employed or actively searching employment during the week of October 1<sup>st</sup>, 2003. Of the 23,200 graduates in the labor force, 22,200 were employed at that time. A table summarizing this information is shown below.

	<b>All recipients</b>	<b>In labor force</b>	<b>Employed</b>	<b>Not in labor force</b>
<b>Mathematics and Statistics</b>	25,600	23,200	22,200	2,400

Table 1: Labor Force Status of 2001 and 2002 graduates in October, 2003 as reported by NSF (2006).

We are most interested in the 22,200 graduates who were employed during this time frame. The survey further investigated how the employment of these graduates related to the bachelor's degrees that each graduate earned. Of the 22,200 who were employed, the NSF reports that only 3,100 (approximately 14%) of these graduates entered occupations in the fields of mathematics or statistics and that 15,600 (approximately 70%) of the graduates are in non-S&E fields, as is shown in the following table.

	<b>All employed</b>	<b>Occupation in same broad S&amp;E field as degree</b>	<b>Occupation in different S&amp;E or S&amp;E-related field</b>	<b>Non-S&amp;E occupation</b>
<b>Mathematics and Statistics</b>	22,200	3,100 (14.0%)	3,400 (15.3%)	15,600 (70.3%)

Table 2: Relation of occupation to field of degree of 2001 and 2002 graduates in October, 2003 as reported by NSF (2006).

We would like to argue, however, that the data in this table is misleading. Although only 14% of mathematics or statistics graduates entered occupations in the same broad S&E field as their degree, the National Science Foundation does not include those who teach mathematics at the secondary level as being in S&E fields, despite the fact that a degree in mathematics is generally necessary for such a career. Therefore, high school mathematics teachers are included in the category of having a career in a non-S&E field, even though they have entered the career for which their degree was intended. Therefore, we believe that this analysis of the data provides a skewed perspective of how many mathematics and statistics graduates leave the field after earning their degrees. Since 7,500 of the graduates claimed that teaching was their primary work activity for their job, we would rewrite the previous table as follows:

	All employed	Occupation in same broad field as degree	Occupation in different S&E or S&E-related field	Non-S&E occupation
<b>Mathematics and Statistics</b>	22,200	10,600 (47.7%)	3,400 (15.3%)	8,100 (36.5%)

Table 3: Relation of occupation to field of degree of 2001 and 2002 graduates in October, 2003 that includes high school mathematics teachers as having an occupation in the same broad field as their degree.

Although we realize that there may be some error in this data as a result of combining two different data sets, we believe Table 3 to be a more accurate representation in determining how many students are *leaving* the field of mathematics and statistics. While these numbers are much less drastic than those of Table 2, these data still suggest that more than *one third* of the graduates earning degrees in mathematics or statistics are leaving the field within one to two years of completing their degrees.

Although students leave the field of mathematics for many reasons (Besecke & Reilly, 2006; Herzig, 2004a; Herzig, 2004b; Stage & Maple, 1996), it has been suggested that one reason students may be leaving is because they do not know about possible career options in the field (Linn & Kessel, 1996). This theory has also been supported by the work of Seymour and Hewitt (1997) which can be heard through the following voices of students who had been majoring in mathematics but then switched to another major before graduating:

I talk to some of my friends who are math majors right now, and they're saying, "What am I going to do."... People say you can do so much with a math major - the problem is finding it. (mathematics major, switcher) (p. 260-261)

I always loved math, but, all of a sudden, I'm coming into sophomore year, and I started thinking about what I was going to do with my life... And people start asking what I was going to do with a math major, and where I was going to work, and I had no idea. (mathematics major, switcher) (p. 36)

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These students in Seymour and Hewitt's study left the field before earning their bachelor's degree in mathematics, however, their comments resonate with the comments stated by many of the participants in our study. Though our participants had chosen to complete their degrees in mathematics, many had no idea what they would do upon graduation or what kinds of careers were even available to them with a bachelor's degree in mathematics. With such little guidance and knowledge of their future career options, it is almost expected that these students may leave the field for the first viable job that they find. Therefore, in order to better retain the graduates within our field, it would be useful for the mathematics community to better inform mathematics students of their career options. This could be done in many ways: advisors could provide career information to students when they declare their majors; mathematics faculty could relate content taught in their classes to specific careers; colloquium that provide information on employment in mathematical careers could be held for students to attend; and informational bulletin boards could be posted in the hallways of the mathematics classroom buildings.

We would also like to note that we find it concerning that the students in the methods course, in general, did not know much about careers in mathematics other than teaching. Although one may argue that since these students intend to enter the field of teaching they need not be aware of other careers available to them with a degree in mathematics, we would argue that as future mathematics teachers, these students will be advising the next generation of high

school students with their future careers. If the mathematics community is interested in satisfying the national need of recruiting and retaining more students in the field of mathematics, then we must be forward-looking and provide these students' mathematics teachers with the knowledge of what careers could be available to someone with a degree in mathematics.

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