

## MATHEMATICS STUDENTS TRANSITIONING INTO THE WORKFORCE: INFLUENCES ON CAREER CHOICE

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*Currently, there is a shortage of Americans entering STEM careers. Furthermore, women remain underrepresented in these fields. In this paper I discuss the career decisions of three undergraduate women mathematics majors who, during their undergraduate years, expressed an interest in obtaining a career in mathematics but lacked substantial knowledge of potential careers. I explore how these women transitioned from college into the workforce and how their career decisions were based, in part, on aspects of their identities and on environmental opportunities. The implications of this work provide knowledge to the field of how to retain certain individuals in the field of mathematics.*

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Currently, there is a shortage of Americans entering STEM (Science, Technology, Engineering, and Mathematics) careers in the United States (National Academy of Sciences, 2010; Huang & Cohen, 2012). Although there does not appear to be a consistent definition amongst national organizations of what is classified as a STEM career, an unspoken definition appears to be any career that requires the knowledge of a Bachelor's degree in a STEM field (excluding careers in K-12 teaching). The shortage of those entering STEM careers is not necessarily due to a lack of talent, but rather is based on the reality that Americans, for various reasons, simply are not choosing to enter these fields. Furthermore, national statistics demonstrate that women remain underrepresented in mathematics and science fields (BLS, 2011). Given the national need for more individuals to enter these disciplines, the underrepresentation of women in these fields should be of widespread concern.

There are many critical junctions within individuals' lives when they make decisions that influence their future career opportunities. Prior research demonstrates that women choose to leave the STEM career pipeline at disproportional rates at every junction along this trajectory. Girls as early as eighth grade demonstrate less interest in obtaining a future career in mathematics or science than their male peers (Riegle-Crumb, Moore, & Ramos-Wada, 2011). Women are less likely than men to declare a college major in a STEM field and are more likely than men to switch their major away from a STEM field prior to graduation (Seymour & Hewitt, 1997). What is unique to mathematics, however, is that women choose to major in mathematics at the same rate as men (NCES, 2010), but are less likely to enter graduate school in mathematics and are more likely to choose to leave graduate programs in mathematics prior to completing the degree than men (Cleary, Maxwell, and Rose, 2010; Herzog, 2004).

There are a multitude of factors that influence women's decisions to leave the mathematics and science fields. Some of the most common mentioned in the literature are the absence of role models, STEM curricula and pedagogy, women's attitudes and beliefs about the fields, cultural pressure, and a 'chilly climate' (Blickenstaff, 2005). Furthermore, it has been argued that not necessarily the same factors affect all areas of science equally and the factors may differ for science and mathematics careers (Riegle-Crumb, Moore, & Ramos-Wada, 2011). Therefore, it is important to study women in mathematics separately from those in other STEM fields.

In my work, I analyze what factors influence undergraduate women mathematics majors' academic and career decisions. In this paper, my analysis surrounds the career decisions made by women who, during their undergraduate careers, expressed an interest in obtaining a career in mathematics but lacked substantial knowledge of potential careers. This paper discusses how these women transitioned from college into the workforce and highlights the role that aspects of their identities and environmental opportunities played within their career decisions.

These women's experiences and career decisions are worthy of a focused analysis because these individuals desired a career in mathematics and had the proper education to obtain one, but lacked knowledge of potential careers. Learning about what led to their career decisions provides knowledge to the field of how to retain certain individuals in the field of mathematics.

### **Theoretical Framework**

Many scholars have explored social and cultural reasons for the shortage of women in STEM careers (Blickenstaff, 2005; Hanna, 2003; Spelke, 2005; Wallon, 2005). One perspective is that of the "glass ceiling", suggesting that women are not given the same opportunities as men to succeed in the STEM fields through means of discrimination. That is to say that external barriers prevent women from being successful in these fields. Another perspective is that the shortage of women in these fields is a result of choices made by women. In other words, women are making the decision themselves not to pursue STEM careers. This perspective gives agency to women and views them in control of their own life decisions (Damarin, 2000).

In my work, I follow this latter perspective, focusing on the educational and career choices made by women. This perspective does not ignore external barriers or cultural norms. Rather, it views women as having the choice of how to allow these factors to influence their beliefs and decisions.

When considering what influences an individual's choice of career, research demonstrates that the situation is complex. Eccles and her colleagues (2011, 1994) have developed a framework on achievement-related choices that takes into account the role gender plays within these decisions. In this framework, educational and vocational choices are most directly related to the individual's expectations for success in a field and the subjective task value (STV) that they attach to a field. STV is described as having four major components: 1) utility in facilitating one's goals or external rewards, 2) enjoyment, 3) ability to manifest one's identities and core values, and 4) the cost of engaging in the activity (Eccles, 2011).

In this framework, an individual's beliefs are based on a complex interplay of multiple factors, such as cultural norms, personal experiences, input by significant people in their lives, gender-role beliefs, and perceived ability, all of which are affected by one's gender. It is this framework that has informed my analysis of the choices made by the women in my study.

### **Methods**

The study described in this paper is a part of a larger longitudinal study analyzing the experiences and career selection of women mathematics majors. As part of the larger study, I conducted a series of three 90-minute interviews with 12 undergraduate women mathematics majors at two different universities in the Midwestern United States to learn what motivated these women to major in mathematics and to learn about their future career goals. I employed the interview technique known as in-depth, phenomenologically-based interviewing and followed the Three-Interview Series protocol as described by Seidman (1998). The interviews were conducted during the student's junior or senior year of college and generally took place over the span of one month. Then, three to five years after the initial interviews, I conducted a

one-hour follow-up telephone interview with eight of the original 12 participants, to learn what influenced their career decisions since graduating from college. For this paper, I will focus on a subset of three of these participants as described below.

All 12 of the original participants were U.S. citizens, had Caucasian heritage, grew up in the Midwestern United States, and attended college immediately following high school. Of the original 12 participants, half were planning to become middle or high school mathematics teachers. The remaining six participants had consciously made the decision not to have a career in teaching. Of these six, three had specific career goals that they were working towards. The other three participants, however, did not have any specific career plans, in part because they did not know what careers were available to them in the field of mathematics. It is these three participants who are the focus of this paper.

All interviews were audio-recorded and transcribed. The four interviews for each of the participants (three while they were students and one 3-5 years later) were critically analyzed and coded inductively with regards to these women's desired career qualities and what influenced their actual career paths. For each participant, common themes were noted between the participant's first set of interviews and the follow-up interview three to five years later, emphasizing validity within the data. Profiles were then created for each of the participants in order to accurately represent each woman's account (Seidman, 1998). The profiles were then analyzed for common themes arising between the women's experiences.

### Findings

The three participants I focus on in this paper have earned bachelor's degrees in mathematics. They all chose this major because they had strong mathematical identities and because they enjoy the field of mathematics (Piatek-Jimenez, 2013). Despite their choice of major, however, while they were undergraduates they were unaware of what careers they could obtain with a degree in mathematics. In fact, all three of them specifically stated that the biggest obstacle to entering a career in mathematics is not knowing what their options are. In this section I provide details of how each participant transitioned into the workforce. In the following section, I analyze the commonalities found amongst these participants' experiences and decisions with regards to Eccles' (2011, 1994) framework.

#### Kelly

While an undergraduate, Kelly was unaware of potential careers available to her upon graduation with a major in mathematics. People frequently told her that mathematics is a good field to enter because of the many career options available, but when pressed, no one seemed to know what these options were. In an attempt to learn more about potential careers, Kelly spent a day job-shadowing a banker and attended a talk by a mathematician at the National Security Agency, but determined that neither career was a good fit for her.

When considering what qualities she wanted in a career, Kelly mentioned that she did not want a desk job. She considers herself to be a social and active person and wanted a job with human interaction and physical activity. She claimed, "Working at a desk is 'ugh'; I like to get up and move around."

Because of her Spanish minor, Kelly initially planned to study abroad during her senior year of college, however her plans changed when she learned how expensive studying abroad would be. Instead, Kelly opted to graduate a semester early and travel abroad once she graduated:

Part of the reason why I decided to go abroad was because I wanted to study abroad, but I didn't want to pay all the money to study abroad. So, I thought a good goal was for me to graduate early and then use that extra semester to go abroad for four months or for six

months... The first country I went was Russia... My purpose was to pick a Spanish speaking country, but I just, Russia sounded like a little bit more fun. So, but then I did end up going to a Spanish speaking country after that... [In] Russia and South Korea I taught English, and then, in the Dominican Republic I worked as an event coordinator at a resort.

Even though Kelly initially planned to live abroad for only four to six months, these short-term plans lasted two and a half years. For each position, Kelly was hired for a fixed amount of time and after each contract expired she would return to the U.S. for approximately one month before leaving again for the next country. "I could have stayed in each of those places, but I just, I wanted a new experience, something different." When asked if she had considered math-related positions, too, Kelly responded:

The type of position that I wanted was the short-term position, and the math positions were all relocating there for four or five years, and that was something that I wasn't willing to do. So, I was just going for the short-term positions.

Most recently, Kelly obtained a job in her home state as a middle school Spanish teacher. Although she had been looking for another job abroad, she had not yet found one that was a good fit for her. She then learned through her father that there was a position opening mid-year for a Spanish teacher in her hometown. Given the need of the school district, they hired her without a teaching credential. Since Kelly did not have another position abroad lined up yet, she decided to take advantage of this opportunity that arose.

Although Kelly had initially determined that she did not want to become a teacher, now that she is in the classroom, she is happy with this decision for the short-term:

I'm enjoying my job for the most part and everything like that, but I don't know if that's something that I could really do for long-term... I'm going to be focusing on teaching at least for the next five, ten, years or so... I've just kind of fallen into [teaching] and it seems to be working out well, so yeah, I might as well pursue it a little bit and see what happens.

Although Kelly is currently a middle school Spanish teacher, she has begun an online program to earn a teaching credential in mathematics, with the hope of eventually finding a position teaching mathematics. She explains this decision by saying, "Even though Spanish seems to be where things are taking me now, math has always had a soft spot for me in my heart. I just, I think it's fantastic!"

### **Mandy**

Despite her decision to major in mathematics, Mandy did not know what she wanted to do once she graduated. Mandy even felt embarrassed when people would ask her what she was going to do with her degree because she would have to tell them that she did not know. She simply knew that she did not want to have a career doing pure mathematics. "I just like applying math to things. I don't want to do pure math... I want to apply my math skills to something bigger than math. So, to another field [such as] biology maybe."

Upon graduation, because Mandy did not know what career path to pursue, she decided to go to graduate school. "I think part of it was I didn't know what my options were for finding a job." She ended up applying to two very different graduate programs. One of the programs was in applied mathematics while the other was in information communication sciences. Mandy learned about the latter program through a colloquium talk given at her university. In making her decision of which program to attend, Mandy claimed, "It almost came down to a coin flip between [the two programs]. I got assistantships at both of them, but I just felt like I needed a change of pace from math and I wanted something with more communication tied in." In the end, Mandy decided to do the Master's program in information communication sciences. Even

though she was not certain whether this program would be a good fit for her, knowing it was only an 11-month program, she figured, “I can do anything for a year.”

Throughout graduate school, the director of the program took it upon himself to mentor Mandy. The same professor also assisted Mandy in obtaining multiple job interviews, one of which led to her current position. Mandy has found a job as an IT consultant at a consulting company in a large city. The majority of this company’s clients are in the healthcare sector. Mandy described her current work as follows:

I’m helping with a wireless appointment, and now we are doing one in a new hospital here. So the access points are installed and we walk around with a survey tool tweaking the coverage areas and making sure that the radio frequencies are at the power levels to make sure that it’s at the right level without being too high. So, I really like that cause it’s like a puzzle.

Mandy claims that while she may not be using specific content that she learned as an undergraduate, she is using many of the skills she obtained as a mathematics major, “the problem-solving, the thinking, the analyzing, all those skills I gained learning to write proofs.”

Mandy really enjoys her job because she likes doing “technical” work. She also enjoys that she is out in the field each day. “I *love* that I don’t sit at one desk all day. I like that it changes it up.” The only concern that Mandy has about her current job is that she travels approximately half the time, and if in the future she gets married or has children, Mandy does not want to continue traveling so extensively. She does state, however, that she would still want to have a job in a “technical field.”

### **Nicole**

Like the other participants, Nicole did not know what careers were available to her upon graduation. Her father was a high school mathematics teacher, but Nicole did not want to enter the field of teaching because she desired “a more glamorous job.” She knew, however, that she wanted to stay within the field of mathematics.

During her senior year, Nicole saw an advertisement on Facebook for “Math for America.” Through this program, she would be able to earn a Master’s degree from Columbia University Teacher’s College with all expenses paid and then teach in New York City’s public schools for four years after completing her degree. Despite the fact that Nicole had originally decided not to enter the profession of teaching, given that she was close to graduation and did not know what other options she had, she chose to apply to this program.

At the time, Nicole clearly stated that she did not envision herself remaining as a teacher for a long period of time. She simply saw this as a short-term opportunity and not as something that would lead to a future career. The fact that it was a short-term program specifically appealed to her because she felt it would give her time to discern a long-term career goal.

Upon completing her Masters degree, Nicole learned that the “Math for America” program would continue to pay for her to take a college class each semester for the next four years while she taught in the New York public schools. She decided to take advantage of this opportunity and began a PhD program in mathematics education:

Because I was getting, like I could get those classes for *free* I kind of thought, “Well, I could do this PhD and that would be cool” I guess. But I mean that’s really kind of; if it hadn’t of been for that, I probably wouldn’t have started it.

Since that time, Nicole has been taking two courses a semester and is currently on track to complete her PhD over the span of four years.

Upon completing her PhD in mathematics education, Nicole is still unsure of what career path she will take. “I don’t really know what I can, what I’m going to do with it.” One option she is considering is a teaching job at a university, but she clearly states that she would only be interested in a position teaching mathematics, rather than teaching education courses, demonstrating that she still wants a career with an emphasis on mathematics.

Reflecting on her decision to join “Math for America” after college, Nicole says that she does not know if she would make the same decision again:

I don’t know... I wouldn’t say that I regret it... I’m not sure if I would be able to do anything differently if I could go back... I don’t know that I’m that happy with what I’m doing right now... I guess I’m as unsure as I was three years ago... I kind of think I just really didn’t know what I wanted to do. (sighs) That kind of started to get me to change my mind [about teaching].

Nicole admits that while she is not necessarily happy teaching, four years out of college she is no more knowledgeable about careers in mathematics than she was when she graduated. She also clearly states that the reason she chose to go into teaching was because she felt like it was her only option. She does admit though that one thing that was appealing to her about teaching was “I didn’t really want to have an office kind of job.”

### Analysis

Although these three women transitioned into the workforce in very different ways, there are some common themes that permeate their stories. At the time of graduation, all three of these women remained interested in wanting careers in the field of mathematics. Because of their lack of awareness of careers that also fit other desirable job qualities (for example, not wanting a desk job), they chose short-term options instead of focusing on long-term plans. For Kelly and Nicole, their short-term jobs were in fields they knew they did not want to remain in for a long period of time, but that satisfied other short-term goals, such as traveling abroad or earning a Master’s degree. These decisions appear to be the results of trying to postpone making long-term career plans. In Mandy’s case, initially unsure whether her short-term plans (her Master’s program) would lead to a long-term career, she chose an option that could potentially prepare her to have a career in a STEM field.

According to Eccles et al. Model of Achievement Related Choices (Eccles, 2011), the two sets of beliefs that most directly influence an individual’s career choice are expectations for success and subjective task values. The first of these, expectations for success, influenced these women’s choice of major (Piatek-Jimenez, 2013), but did not appear to influence their career decisions. This might be, in part, because these women were entering short-term careers. Since their jobs were not intended to be long-term, their expectations for success was less influential on their decisions.

On the other hand, the role of subjective task values appeared to be instrumental in their short-term career decisions. In particular, their decisions were based on a synthesis of the components of enjoyment and the ability to manifest one’s identities and core values. These three women all identify as “math people”, yet they also identify as social and active individuals. Their limited knowledge of mathematical careers, however, prevented them from being able to obtain a career in mathematics that satisfied all three of these aspects of their identity. As a result, they placed their identity of being social and active as a priority, at least for the short term.

Both Kelly and Nicole found jobs that allow them to be both social and active at work, yet they are not content with their current positions. They had both chosen short-term jobs hoping to later learn about mathematical careers that fit their desired career qualities. Despite being three

to four years beyond graduation, they are no closer to being knowledgeable about such careers. Therefore, they are still searching for their desired long-term career.

Mandy, on the other hand, entered a graduate program in information communication sciences, which has allowed her to obtain a career that is active, social, and “technical” in nature. Although she is no longer in a mathematical field, it appears that being in a different STEM field is satisfying this portion of her identity. Mandy is aware, however, that later in life if she gets married, her identity will change and that her current position may not fit the needs of those new aspects of her identity. Therefore, it appears that Mandy has successfully transitioned into the workforce by obtaining a career that satisfies her needs, at least until these needs change.

It is also interesting to note the role that environmental opportunities played in these women’s present career paths. Each of these women are currently following a career trajectory that was proposed to them at a time when they were discerning their next educational or vocational decision. Given their limited knowledge of mathematical careers, any opportunity that arose became a consideration, even when this opportunity did not entirely satisfy their desired career qualities. It is also important to note that when these women needed to make concessions, they chose to follow a career path that more closely aligned with gender-role affirming aspects of their identities (Morgan, Isaac, & Sansone, 2001).

Furthermore, all three of these women expressed receiving support from their families in their career decisions; however, they also believed that their parents would have been supportive regardless of their actual career choice. This unwavering support, as well as having the financial means to explore short-term options, may have also influenced these women’s career decisions.

### Discussion

Previous studies have focused on specific reasons individuals have consciously chosen to leave the field of mathematics or other STEM disciplines (Herzig, 2004; Seymour & Hewitt, 1997). The results of my study suggest that some students leave the field of mathematics not specifically due to the desire to leave, but rather because of a lack of awareness of careers in the field. In order to retain more people in the field of mathematics, this population is important to study. These individuals should be among the easiest to maintain in the field, given their desire for a career in mathematics.

This lack of knowledge of mathematical careers exists amongst both male and female mathematics students (Adhikari et al., 1997; Piatek-Jimenez, 2008). Therefore, this is likely to be a reason that both men and women do not remain in the field of mathematics. Given the need to increase the mathematics workforce in the U.S., a national agenda to inform talented students about mathematics careers may be successful in retaining more students within these fields.

The dispersion of career information may assume a number of different forms. A handful of books have been published to assist students in learning about careers in mathematics (Burnett, 2002; Lambert & DeCotis, 2005; Sterrett, 2002). More one-on-one mentoring of mathematics students by university faculty may be useful. Companies and graduate programs may consider visiting universities to actively recruit potential candidates. Furthermore, mathematics departments might consider synthesizing these ideas by creating a capstone course, whose primary responsibility would be to assist students in the transition into the workforce by utilizing the books listed above and guest speakers to inform students of career options in mathematics.

Simply providing information of such careers may not be sufficient, however, if these careers do not encompass other qualities these individuals desire from a career. Given the role that gender plays on one’s subjective task values (Eccles, 2011), men and women generally value different qualities within a career. For example, in general, women tend to have a stronger

preference for careers that involve social interaction, helping others, and flexible schedules (Eccles, 2011; Morgan, Isaac, & Sansone, 2001). Therefore, a variety of career opportunities that encompass these qualities need also be proposed.

Finally, when needing to choose between aspects of their identities, intentionally or not, the women in this study placed gender-role affirming qualities as a higher priority than qualities that challenge their gender-roles. More research needs to be done to learn if this is a wide-spread trend, and whether or not these decisions are also influenced by culture or social class.

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