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### **Stories about Math: An Analysis of Students' Mathematical Autobiographies**

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## Stories about Math: An Analysis of Students' Mathematical Autobiographies

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### Abstract

This paper analyzes 16 preservice secondary mathematics education majors' mathematical autobiographies. Participants wrote about their previous experiences with mathematics. All participants discussed why they wanted to become mathematics teachers with the key factors being past experience with mathematics teachers, previous success in mathematics classes, and the intrinsic rewards associated with helping others with mathematics problems.

**Key words:** Autobiographies; Preservice teachers; Mathematical attitudes

### Introduction

Government and educational leaders in significant numbers view STEM (science, technology, engineering, and mathematics) education as the key to the nation's success (Engler, 2012). The demand for STEM majors is high and we need good teachers in order to produce them (Guillaume & Kirtman, 2010; Wang, 2013). This study expands upon existing research on how mathematics is perceived and defined by future teachers. As such, the study's findings, in conjunction with the extant research in this area, potentially enable us to better address the problem of teacher recruitment and retention.

Mathematical identity is an individual's concept of who he or she is mathematically. Students' mathematical identities can aid in understanding why some students are attracted to the field of mathematics and others are not (Bishop, 2012; Boaler, William, & Zevenbergen, 2000; McCulloch, Marshall, DeCuir-Gunby, & Caldwell, 2013; Nasir & McKinney de Royston, 2013). Having students write mathematical autobiographies is becoming more common in the research literature (Ellsworth & Buss, 2000; Harkness, Ambrosio, & Morrone, 2007; Millsaps, 2000; Shaw & Chessin, 1996). Sliva and Roddick (2001) collected and analyzed the mathematical autobiographies of 72 elementary, middle, and secondary teachers. The important themes included the role of the teacher, anxiety issues, family issues, and challenging material.

Narrative can be used to understand individuals, as "stories are the form in which individuals understand themselves" (Drake, 2006, p. 582). Previous memories form current views of mathematics (Lipovec & Antolin, 2014; Pajares, 1992; Sliva & Roddick, 2001). A mathematical autobiography "provides evidence to show how individuals negotiate their identities and, consequently, experience, create and make sense of the rules and roles of the social worlds in which they live" (Goodson & Sikes, 2001, p.2).

Since there continues to be difficulty both recruiting and keeping teachers, it is important to understand why students want to become mathematics teachers (Curtis, 2012). Most research indicates that the prototype of students who want to become mathematics teachers takes the following form: These are individuals who want to work with children, have a love of mathematics, and believe that teaching will bring them the feeling of personal fulfillment (Curtis, 2012; Manuel & Hughes, 2006).

### Method

The 16 participants in our study are college students enrolled in an upper-division mathematics class at a comprehensive university in the upper Midwest in the United States. The class is geared toward students majoring in secondary mathematics education. Twenty students were enrolled in the class, but four students did

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not turn in an autobiography. The students were offered extra credit for completing the autobiography. Two of the four who did not complete the task were failing the course. The remaining two received a B+ and an A-, and thus the extra credit would have helped their grade. Fifteen participants were Caucasian and one was Asian, while 11 were female and five were male.

The instructions given to the potential respondents are included as the Appendix. In short, students were asked to describe their experience with mathematics up to this point and, in their narrative, to describe what they think mathematics is. This particular study is unique in that we did not test formal hypotheses. Furthermore, we did not pose detailed or specific research questions (e.g., What do preservice secondary mathematics majors think about using calculators in mathematics classes?). Rather the overarching research question guiding the study is: What key ideas/themes emerge in the mathematical autobiographies of preservice secondary mathematics majors? Our approach was very inductive. We wanted to discover how respondents would craft their narratives and did not want to influence them in any particular direction. Generally, we expected respondents' mathematical autobiographies to be reflective of their mathematical identities. As we detail in this paper, the analysis and interpretation of the data we gathered is consistent with findings in related studies, but the body of data also took us in some directions we hadn't necessarily anticipated.

*The Polish Peasant in Europe and America*, by Florian Znaniecki and William I. Thomas (1918), was a classic work in sociology that focused on the experiences of Polish immigrants and their families, as evidenced in immigrants' personal documents (e.g., personal letters). We can look to this classic work for guidance on how to approach the analysis of the rich autobiographies that we have collected. As Stanley (2010) notes, they outlined the process as "starting with the general and specific and analyzing this to reach generally applicable conclusions by comparison with like cases. They emphasize that this is not an individualist approach, but a matter of locating people in their social milieu" (p. 145). Here, Stanley provides the following quote from Znaniecki and Thomas:

'The original object-matter of every science is constituted by particular data existing in a certain place, at a certain time, in certain special conditions, and it is the very task of science to reach, by a proper analysis of these data, generally applicable conclusions... Every individual... must be first taken and understood in connection with his [sic] particular social milieu (1911).'

Thus, what is possible is a construction of "general types." Similarly, we analyzed each respondent's autobiography, noting key ideas/themes, and we engaged in an iterative process whereby we arrived at overarching categories that enabled us to make sense of the data. Importantly, we kept foremost in our minds the larger cultural milieu in which these autobiographies were written. For example, our respondents are college students who are taking a particular mathematics course in which they are asked to provide an autobiography, and of course they are also members of the wider society from which they have undoubtedly "soaked up" (directly or indirectly) particular ideas about mathematics.

Once all of the autobiographies (data) had been collected, each researcher read each autobiography separately. We followed a grounded theory approach, allowing themes to emerge. We then met together to discuss the level of agreement on themes. Although each person used different wording, there was 100% agreement on the themes. Once a wording for the themes was agreed upon, we again separately tallied which autobiographies met each theme. Although we do not report quantitative results, this did allow us to calculate an interrater reliability score to make sure that we were in agreement. The original interrater reliability statistic was 96%, and we reached 100% after discussion.

Again, returning to our key research question of what ideas/themes emerge in the mathematical autobiographies of preservice secondary mathematics majors, we suggest that the results help inform how preservice secondary mathematics majors should be taught, and how we might retain preservice secondary mathematics majors as teachers in the future.

## Results

The primary themes that emerged in the data revolved around respondents' explanations for why they are pursuing a career in teaching mathematics, with the key factors being past experience with mathematics teachers, previous success in mathematics classes, and the intrinsic rewards associated with helping others with mathematics problems. Recall that the participants were not asked to give explanations for why they are pursuing a career in teaching mathematics. However, when asked to write a mathematical autobiography, apparently the fact that they were all pursuing mathematics teaching careers was the main "plot line" of their mathematical autobiography.

### Past Experience with Mathematics Teachers

Fourteen out of the 16 autobiographies devoted a significant portion of their autobiographies to describing elementary and secondary teachers who influenced them in both positive and negative manners. In positive manners, respondents described their former teachers as showing enthusiasm for teaching mathematics and recognizing talent in their students. In negative manners, the respondents stated that teachers did not teach well or taught only procedures. In both cases, the participants in our study remarked that the influence of the teachers was a significant reason for them wanting to become teachers themselves. In the case of positive teachers, the participants wanted to emulate them, and in the case of negative teachers, the participants wanted to do a better job than they did. In both cases, the participants wanted their future students to see that mathematics is fun and that everyone is capable of learning mathematics.

The following quotes (please note that pseudonyms were used in place of the real name of the teacher, where appropriate) illustrate the significant influence that respondents' teachers had on their interest in, and success with, mathematics:

- I had the coolest teacher that I looked up to and his name was Mr. White. He was so enthusiastic about teaching and really wanted everyone to learn.
- Throughout my education I have had many incredible math teachers. My favorite, the one that made me enjoy math, was my calculus teacher in high school.
- Mr. Carlson was my favorite teacher because he was funny. He would always crack jokes in class and make everyone laugh. He was also very friendly and easy to talk to. He actually convinced me to join the math team in 10<sup>th</sup> grade. Back then I would have thought this was a nerdy thing to do, but, he got me to participate anyways.... I think it was Mr. Carlson who made me want to become a teacher of math.

Many of the participants directly credit their teachers with the reason they want to become teachers themselves:

- I was and still am particularly close with the teacher that nominated me for that award [a National Mathematics Award as part of the National Academy of High School Scholars], and she saw the potential in me to become a teacher.... Then I realized I should become a teacher. I want to help students learn how cool it can be!
- I knew I was going to be a math teacher when I was a freshman in high school. I had a teacher whose name was Farly and he was the best math teacher I had for my K-12 experience.
- Math assignments were usually things I rushed through and completed as quickly as possible so I could move on to other activities I enjoyed. This changed when I took a Pre-Calculus course in high school with Mr. Thomas. ... Mr. Thomas and that math class are the reason I registered for a Calculus class my first semester of college and ultimately why I want to be a math teacher.
- ... I had the average math experiences, until eighth grade, when I had Mrs. Brown. This is the best math teacher I had ever seen, and she is the reason why I decided to go to school to teach math as well.

As noted above, the data also suggest that previous experiences with bad teachers greatly influenced the respondents' motivations to pursue a career in teaching mathematics. The following quote is representative:

- I thought back to eighth grade and struggling through geometry, and I realized that all math classes throughout high school for some people go about as well as geometry went for me. And I think a lot of that can be attributed to their teachers. So this is ultimately why I really want to be a math teacher.

In general, when respondents commented on previous mathematics teachers who they considered to be bad at teaching, it was typically because these teachers failed to fully explain the phenomena and would instead give the students short cuts for solving problems. Additionally, these were teachers who did not engage the students as active learners. Our respondents expressed a desire to engage with their future students in a way that will make sense to students and ignite their interest in the subject. So we find that participants' previous experiences with both good and bad teachers are key factors in shaping their evolving mathematical identity.

### Previous Success

The majority of the participants wrote about having previous success in mathematics that made them feel good about mathematics. The success was usually a teacher noting accomplishment or a teacher suggesting the

participant join some type of accelerated group or club. The following quotes describe respondents' feeling special simply because they were good in mathematics:

- ... eventually Mr. Werner chose 5 students who were excelling in the class to meet separately to work ahead and challenge ourselves more. I was chosen as one of those students and felt so special and smart!
- In 6<sup>th</sup> grade there was this elite group of kids who got selected to be a part of the math wizards. Now I say it was an elite group because to me it was a pretty big deal and it made me feel proud of myself and that I was special.

Similarly, other participants commented on the pleasure of being in advanced classes:

- Then in middle school, we got separated into the regular math classes and advanced math classes, and I took great pride in always being in the advanced classes.
- My math experiences so far have been good memories. In high school I was in honors math and took AP math senior year. I think this made my experiences good ones because honors math, while based on your math test scores, and past classes, it seemed like everyone who was in those classes liked math.
- There was a "smart" math class that was more advanced, moved at a faster pace, and competed in Math Masters, and there was the "dumb" math class that went slower and only covered the basics.... The teacher, Mrs. Green, ... petitioned for me to join the accelerated math class...and I fitted right in.

### **Reward of Teaching**

Although the participants were not asked to comment on why they wanted to pursue a teaching career, all of the students did so. All of the respondents commented on wanting to be a good teacher, and this often meant being "helpful" to their future students. In addition, the majority of the participants mentioned that they enjoyed teaching mathematics to friends or siblings. They describe liking the feeling of being good enough at mathematics to explain it to someone else, but they also like the idea that they are, in fact, helping that other person.

In their autobiographies, participants expressed the personal sense of fulfillment in teaching others, as evidenced in the following:

- When I had some of the not so good teachers, I ended up helping a lot of my friends that were struggling and that felt really rewarding.
- Algebra was very easy for me, but I liked being able to help my friends with the homework and explain how to get the answer. It was a good feeling when my friends would understand the process after I had tried to explain it to them.
- There is nothing more rewarding for me than explaining math concepts to students and seeing their face light up when they finally understand something.

Part of the reward in understanding and teaching mathematics appears to be convincing others that mathematics is both doable and fun. The following quotes express this desire:

- I know not everyone learns the same as me and I know how frustrating it can be when the teacher isn't helping you learn in a way easiest for you. I also hope to show others the appreciation for Math and how anyone can do math not just the brilliant people of the world.
- I really want to teach these ages because I feel that's when the door really opens to the math world. ... To me this age is when kids get scared of math and stay away from it for the rest of the schooling lives. I think if you can get them to enjoy it young and not believe it is something impossible more kids will continue on in the field.
- I want to be the teacher who students hope they get for math because I am able to present the information in multiple diverse ways that make it painless to learn.
- Then, after I work at it, it clicks and I am reminded that I want to teach math so that students can learn math isn't as scary and impossible as it seems.
- My youngest brother struggles in school. Every night he has so much homework and my mom takes hours and hours helping him. He really struggles with tests. Watching my brother struggle through math is another factor that has shaped the kind of teacher I want to be. ... That is why I plan to do my best to ensure that every student learns and can appreciate math.

- I want to help students learn how cool it can be! Math is something that I have always wanted to share my passion for. If I can help even one kid in the future to change their mind on math, how they feel about themselves, or even change their life in their education I would be so happy with myself.

### Definition of Mathematics

With respect to participants' ideas about mathematics, we find that their ideas are not static, but rather, change as their life experiences change. The students were directly asked to define mathematics. Ten of the students thought of mathematics as problem solving or applicable to life. That is, mathematics is used to solve problems, and some emphasized that these problems have a significant role in everyday life. The remaining six gave a variety of answers including that mathematics is a language, and that mathematics is about patterns. In previous research (Latterell & Wilson, 2013), we have found that teaching majors often view mathematics as a set of content, until they have enough experience with it, and then they begin to view it more as a process (such as problem solving). The purpose of this study was to invite the participants to share their mathematical stories. Nevertheless, we did directly ask them to define mathematics, and for the most part, the students do tend to view it as a process.

The following are representative quotes in which students view mathematics as problem solving or applicable to life:

- To me math isn't something that you can just simply describe in a sentence... Math is something that you use more often than one expects. But, if I had to sum what I think mathematics is I would have to say it is the use of numbers to determine the answers to a problem placed before you.
- I like to think of math as the way we use numbers, figures, and shapes to solve problems to better our lives.
- Math is used in so many jobs and tasks in the real world.... I believe that Math is problem solving. If you have a problem, you can figure it out with math by either crunching numbers, making a proof, or using thinking skills used in Math to solve the problem.

### Discussion

Approaching this study as we did -- that is, inductively -- allowed for a body of rich data that, had we employed a more deductive, quantitative approach, would not have been possible. The perceptions and definitions of mathematics that respondents provided add to an existing body of research that is valuable for mathematics educators. The detailed accounts of their previous school experiences, which highlight both positive and negative teacher influences, the trajectory of their mathematics success, and the reward discovered in their experience with helping others, paint a picture of key factors that have motivated these students to select their academic major and eventual career. While we might assume that having had poor experiences with mathematics teachers would result in an aversion to mathematics, we find that it can instead be a catalyst for wanting to become a teacher -- that is, one learns what *not* to do and wishes to put into action a better approach to teaching the subject to others. We might also assume that those who pursue becoming mathematics teachers have innate mathematical ability that was evident early on. While many of the respondents do report early success with mathematics, we also find evidence of some bad experiences that cause respondents to question their ability. In other words, the path to becoming a mathematics teacher is not always particularly direct and linear; it can also involve speed bumps and detours.

### Conclusion

Our findings are consistent with other research (Sliva & Roddick, 2001) in emphasizing the important role of the teacher. However, the issues of anxiety and challenging material that Sliva and Roddick (2001) found were not present in our participants' autobiographies. Another interesting difference between the current study and Sliva and Roddick's study is that none of their participants mentioned their future teaching, while all of our participants did so. Sliva and Roddick suggest that mathematical autobiographies might be used with pre-service teachers in order to help students make an explicit connection between their prior learning experiences and their future teaching. Our study confirms that such a connection is a natural consequence of using mathematical autobiographies

## Recommendations

While the findings in this study cannot necessarily be generalized, it is reasonable to suggest that such findings would likely be *transferable* to other undergraduate students at public universities (Lincoln & Guba, 1985). Without asking our participants to address why they wanted to become secondary mathematics teachers, the participants were clear that certain experiences in their K-12 grades led them to wanting to become teachers. While this conclusion may not be surprising, it is nevertheless important. Given the frustrations students express about some of the inadequate or questionable teaching practices they have experienced from some of their former teachers, it bears repeating and emphasizing that teachers, by their words and actions, should provide students opportunities to feel successful at mathematics and to work with other students.

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## **Appendix**

Assignment: Write your mathematical autobiography

- Write in first person
- Write about who you are mathematically, how do you identify yourself mathematically
- Include significant people, events, and experiences that have made you what you are mathematically from as early as you remember until now.
- Include also a statement of what you might wish for the future, mathematically.
- **At some point in the narrative, you should directly state what you think mathematics is.**
- It should be at least 700 words.
- It should be typed.

The following are a list of questions to help you think about this assignment. It is not intended that you answer each one, necessarily.

- What have your math experiences been like so far?
- What is your most memorable moment in mathematics?
- Why is it important to study?
- Tell me about your favorite math teacher to date. What kinds of qualities did you like in her/him?
- In what ways have you used math outside of school?