

Why one wants to be a mathematics major / mathematician

2022 Spring Math 400 group

Abstract

We present some different views on why one wants to be a mathematics major. In particular, we share experiences among a group of W&M mathematics students, and see what motivates them to become a mathematics major, what they plan to do in the future in connections training, and what they expect a mathematics graduate would do. The instructor will also share his experiences on these topics.

1 Introduction

Different people have different reasons to study mathematics, and majoring their study in mathematics, and some become a mathematician eventually. For example, one can see many famous mathematics quote from famous scientists about their views on mathematics; [1]. There are also many articles about why one wants to be a mathematics major, and why one wants to be a mathematician; [2, 3, 5, 4]. In this article, we present some different views on what one wants to be a mathematics major. In particular, we share experiences among a group of W&M mathematics students, and see what motivates them to become a mathematics major, what they plan to do in the future in connections training, and what they expect a mathematics graduate would do. The instructor will also share his experiences on these topics.

In the next few sections, we will describe the experiences of the group of participants. Specifically, they will focus on the questions.

1. When do they plan to study mathematics (to be a math. major) seriously?
2. What are the factors (people) affecting the decision?
3. What are their favorite mathematics courses?
4. What do they want to do in the future using their mathematics training?
5. What related interesting stories they want to share?

2 The sharing of the participants

Some people decide to be a mathematician at very young age, some are opposite. For instance, some people decide to be a mathematician at the age of 3, but some may decide after working for some years after college. People become interested in mathematics for different reasons and under

influence of different people. Some like mathematics a hobby, some like mathematics because of its beauty, its usefulness. The decision to study mathematics may be affected by parents, (good) teachers, famous historical figures. Some want to do mathematics because they think that they are good at mathematics, better than any other subjects; alternatively, some think that they are not good at any other subjects, but they can handle mathematics. For example, see [5]. College students have different visions and plans for their future careers with their mathematical training. Here are some experiences and thoughts of the participants.

- I started to seriously consider becoming a math major the summer after I graduated high school. I had always enjoyed math and especially enjoyed AP Statistics which I took as a senior in high school, and I think that this was the course that made me want to study math.

I think my main inspiration for studying math is honestly that I wasn't really sure what I wanted to do before college, but I knew that math was something I had always been good at and enjoyed. I had also always had very good math teachers in middle school and high school, which made me more interested in the subject. I think it's true that a good teacher can have a big impact on a person's interest in a certain topic, and is certainly true for me.

My favorite math courses have been stats classes like 351 and 352. I also really enjoyed calc 3 and linear algebra. I think I liked linear algebra so much because I took it after calc 3, so it was interesting to see all of the similarities between the two.

I definitely want to follow an applied math/statistics career. I really enjoyed Statistical Data Analysis and I think that finding a job in something related to that would be very rewarding.

- I was good at math in high school, but I did not seriously consider studying mathematics intently until I was 19 or so, at the end of my freshman year, when I got very interested in math again.

I became very fascinated in unusual results in mathematics, and weird things relating to number theory. I especially liked learning about the great unsolved problems in mathematics, like Riemann, and I was also fascinated by the paradoxes in math. Popular youtube channels like Numberphile and 3Blue1Brown helped inspire me to get back into math in college.

I really like analysis: I've taken elementary, intermediate, complex analysis as well as probability/math stats which are analysis-adjacent. I enjoy the proofs in analysis: although they are usually pretty hard to find, once you get it, it is very satisfying.

I plan to use my mathematics education in my economics research, as I intend to get a PhD in that subject and do research professionally. Much of that work would involve analysis, especially calculus and statistics.

One of the first proofs that I saw that really made me interested in mathematics was the Cantor Diagonalization proof for the uncountability of irrational numbers. I thought the proof was simple yet ingenious. This idea that there were multiple levels of infinity was also

very interesting to me, and made me wonder a lot about how numbers, which we all have some intuitive understanding of, are actually quite mysterious when you try to nail down their properties.

- I have always been good at mathematics, but it wasn't until late in high school that I took the discipline especially seriously. I always had a neutral attitude towards the subject, but around junior year I got very interested in a few sciences, including mathematics. In senior year, I suppose, the idea of being a mathematics major became more real; I was in AP calculus and statistics, as well as AP Physics 2, and so my academic year was very math-heavy, and I really enjoyed that. I became more interested in mathematics and psychology by the time I was entering high school, and I enjoyed my mathematics courses (calculus 2 and linear algebra) here enough that I decided to choose the math major over psychology that year.

With the exception of a course here and there, I have always found professors encouraging, kind, and interested in the topics they teach, and that has definitely inspired me enough to help get through some of the stress the major involves. I would say the course that made me confident in my choice of major was Foundations of Mathematics. What I learned in that course was so interesting, and it was a kind of basic knowledge of so many fields of math that I felt it made me much more literate in theoretical mathematics and its methods. The combination of it being basic knowledge (not knowledge that depends on a lot of other things one must remember) and being so theoretical has made it the course that has stuck most with me as well.

I would say calculus/analysis and statistics are my favorite areas in mathematics. The calculus course I took here my first semester was one of the main inspirations for choosing the major when I did apply freshman year; I really enjoyed expanding my abilities and knowledge in mathematics in a more fluid and conceptual way, like in that course.

Right now, my plan is to continue my philosophy education. I will be starting a PhD in philosophy next semester at Columbia University. Since beginning college, teaching and doing research in philosophy has been my long-term goal, but mathematics was a good fit as a plan B because I enjoy the discipline and it leaves a lot of doors open to students who come out of undergrad with a math major. I am not sure which math-related career I would opt for, though. Maybe a statistician working in a lab or for some other kind of research group (e.g., polling)?

I guess what is somewhat unique about my experience is that my mom is a math teacher. She works as a "math coach" now in high school, which means she assists teachers and the school system with math in various ways and does special lessons with students. She would always ask me what we were doing in school, and she would explain something another way if I didn't understand or she didn't like the way something was being presented. I don't know anything about the research about this, but she talks a lot about building number sense and things like that; I do think I have a lot to thank her for in those respects. When I help other students

in high school or college with math, the biggest problem I find is that they try to memorize procedures or ways of manipulating symbols, and serious problems arise when they don't understand conceptually what they are doing. I think she made sure I didn't fall into that trap. For example, I remember that she taught me not to memorize multiplication tables but to perform repeated operations in my head, and this meant I was slower than my classmates at the timed tests we used to do at first. But she said I was so happy when I got home and we had a test with all the combinations of values (e.g., not just $2 \times A$, where $A = 1, 2, \dots, 10$ but $A \times B$, where $A = 1, 2, \dots, 10$ and $B = 1, 2, \dots, 10$) because I did disproportionately well on that test, since many of my classmates had forgotten what they memorized but I had just never memorized it. I wouldn't be surprised if little things like that compound into something very significant by the time you're in high school or college.

- I decided to study mathematics seriously around my freshman year of college

I don't have any particular inspirations; math came easy to me from a young age, but I found it to be less engaging and more frustrating at times during high school.

My favorite mathematics course at WM have been Math 323, 302, and 307. I didn't enjoy the process of 307 (i.e., all the work and frustration), but I found the exercises fulfilling and (in hindsight) I enjoyed the experience.

My goal as an applied math major is to be able to experiment in nearly any field that captures my attention. I've been able to explore interests in machine learning, data science, and computer science because of it and I hope to be able to continue to do so after graduation. I don't intend to make a career in studying math, rather applying it.

I didn't decide I wanted to study math until my freshman year of college (my first year of undergrad was spent at JMU, I transferred at the end of my first year to WM). As a child, I loved math and took pride in my skills in the area, but around high school I found that I wasn't understanding some of the concepts, and that frustrated me. I was still adept in the discipline and did very well, but for classes like geometry and precalculus I felt that I wasn't fully understanding the material, only reproducing what I'd been told to do. And this lack of understanding made me lose interest in it, until I took a college calculus course with a professor who specialized in mathematics, and who could explain to the class quickly and simply the logic, reasoning, and purpose behind the material. It was this that made me realize that I still enjoyed mathematics, in particular I enjoyed understanding it.

- I don't think I can pinpoint a specific age that I decided to pursue math as a university major and potential career. I think it was math that chose me instead of the other way round. I would say that around 20, i.e., when I started college, was the age that I started to appreciate the intrinsic beauty of math and ended up pursuing a degree in the subject.

Voltaire and Bertrand Russell are two intellectual figures that exerted tremendous impact on me, not necessarily because of their mathematical contribution (the former wrote the Elements

of the Philosophy of Newton and, needless to say, the latter was a major contributor to the field nevertheless), but because of their advocacy of rationality, and I view mathematics as the antidote to the irrational behaviors that we as humans commonly display. In this sense, both characters figured importantly on my decision to pursue mathematical study.

I think liking an area of mathematics or not is highly dependent upon one's experience learning it. I thought I hated proof-based mathematics, but the instructor of the Elementary Analysis (Math 311) course I took here at William and Mary made the experience very pleasant. Overall though, I found probability and statistics to be most fascinating among the fields of mathematics most likely because I love to have statistics inform my opinion.

I have not decided on what to do with my mathematical training in the future, but I enjoy written communication, and I would hope to be a writer that focuses on mathematical and scientific writings.

My experience with mathematics has not been entirely positive. As I pointed out during the discussion, I have not passed any major math exams during elementary and middle school, and my confidence really took the toll as I toiled through the first few years of my early education. I think, however, that a quote that is often attributed to Einstein puts it well: "if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid." While I am not in a position to judge the educational system, I do think it is the failure on the part of the establishment to judge a person's intelligence on exam performance. I suppose the sentiment that I was trying to get at, albeit cynical, is that math is for everyone, but higher education might not be.

- I decided I wanted to start focusing studying mathematics after my first semester in college. I originally planned on studying to go on to med school, but after I took chemistry, and relearned the material I had gone through twice in high school, I decided that was enough for me and medicine or becoming a doctor was not for me anymore. At that point I was also enrolled in linear algebra, too, so I decided to continue with studying math since I enjoyed learning about it.

My math teacher during my sophomore year of high school and my father was an inspiration to study math more in the future. My high school math teacher had an outgoing and energetic approach toward teaching math and sharing his enjoyment with us. Hardly ever would a class be slow or boring such that you would not want to pay attention; He was spontaneous and would randomly call out to students, so you had to be paying attention. Additionally, he did a good job of explaining difficult concepts. So, his energy and passion for math rubbed off on me a little and led me to study math in college. My father is also an inspiration to me since he is currently an engineer and would always mention upper-level math topics and always seemed to have no issue solving questions I would come to him with. For that reason, I wanted to study more math so I could communicate with him about topics and understand his work.

In the first half of my college career, I enjoyed applied math and seeing how concepts I learned could be used in the real world. Specifically, I noticed this with multivariable calculus; I often had an “Ah! I could see this used here or here, etc.” thought as we learned double and triple integrals and then divergence and curl theorems. However, I took a mathematical physics course at the end of my second year and that somewhat led me to not like direct science applications as much. And after I took abstract algebra the following semester, I think I started to appreciate and like theoretical math just a little bit more than I used to. I certainly struggled in abstract algebra, and concepts often went over my head, but it was a course that knocked me back down a few pegs and told me that there was so much more out there that I don’t know (and probably won’t fully understand), but still deserves a chance to be studied on my own. For example, to me, Topology seems like a bizarre field of math that has conclusions that don’t logically make sense (like how a plate and a cup are the “same thing” yet cannot be used interchangeably). And, although I probably would have a difficult time understanding the rest of the topics that are taught in a topology course, I would still love to take it and experience what it is all about.

For the most part, I am undecided in what I want to do with my mathematics education. I have thought about doing work with civil engineering or urban planning, and using math/operations research to help create or design efficiently designed cities and towns.

To expand from the unique character of my high school math teacher, I recall several his tests including questions that were unlike typical math test questions; Hardly ever did he include typical “solve this equation” type questions, they tended to be more out of the box and required you to think heavily about the foundations of what we were learning and apply them. I remember his class was the first class where, when it came time for midterms/finals, I had no idea what to study or how to study, since anything ranging from major sections in the textbook, to minor details/properties about a line or a plane (for ex), could be tested. It was stressful, but at the time it was still thrilling in a sense to walk into an exam, not knowing what would be asked of us.

- My interest in math came at a very young age. The earliest enjoyment I remember is back to first grade but mainly elementary school.

People that really inspired me was my mom and dad as they would always teach me faster and more efficient ways to do basic math when I was little which helped further my interest in the subject. Someone else that inspired my liking to math was my senior year calculus teacher in high school He took the subject very seriously and believed that there were gimmicks that we were taught when we were young which hindered understanding. For example, saying canceling out when things divide to one or not showing that the square root of x^2 is $|x|$ and not just x .

Some of my favorite math is financial math like MATH 110 and computational math in general. I like the challenges of trying to solve hard problems and the satisfaction of coming

to the right answer when you are finished.

In the future, I plan to become a financial actuary as this combines my interest in the business world with my liking to math. I know it is a hard path with the actuary exams but I accept that challenge.

One interesting story I can remember is when my parents taught me traditional multiplication before I learned it in school. I do not remember why I asked to learn it but I distinctly remember them teaching me while we were at dinner in a restaurant. I remember that for the remainder of the meal my parents were just giving me multiplication problems and them just watching me do it for no reason other than I was happy I was gonna know how to do it before my classmates.

- I always enjoyed math growing up and it was very natural to me. I went to a very small high school, I had an amazing calculus teacher and always had friends in class, so math was always a fun and collaborative environment for me. I also felt that math came easier to me than it did for some other people, so I had a sense of accomplishment about it. I had thought about majoring in math in college, but didn't seriously consider it until sophomore year of college. At this point, I had abandoned my Computer Science aspirations and was looking for a new field to study in and I enjoyed that math seemed to be an intersection of a lot of my different interests.

I had a close friend the year above me in college who was majoring in math who helped me in my math journey and was able to advise me. I also made friends along the way that made math more enjoyable. I always enjoy my statistics courses and enjoy being able to use math and analyze data in a more hands on way.

In high school I loved my AP Calculus AB class, and then I enjoyed Calculus II when I got to college. I also enjoyed multivariable calculus later on in my college career. MATH 352 and 351 were also very interesting to me, as I love statistics. I do not enjoy the more pure math classes, such as 214 or 307.

I'm not sure yet what I want to do in the future with my math knowledge, but I know I am not interested in being a pure mathematician, and would much rather apply my knowledge to another field. I would enjoy modeling and analyzing data and statistics in another field, like sports or geology, if possible. Math is also used in geology, especially for hydrologic research, so I am interested in diving further into that field as well.

- I never really decided at one point that I would 'be a math major', I just thought it would be a good idea to keep taking math classes every semester to challenge myself intellectually; it made sense to add the major given all the math classes I would be taking. So, I suppose that I 'decided' to be a math major after the last semester of my senior year of high school when I took Linear Algebra and ODEs, since I knew then that I would keep taking math classes during college; I was 17 at that time.

I am mostly inspired by mathematicians, like Gauss and Euler, who were so great at what they did that they eventually found themselves looking down on everyone around them. That kind of greatness to me is same kind of greatness as athletic or artistic greatness. Of course, these mathematicians were born with a natural talent that I do not have, but the success they achieved has inspired me to study their work, like an amateur athlete tries to study the work of a great athlete, or an amateur painter tries to study the work of a great painter.

I am interested in pure math. Some applied mathematics is interesting to me, for example PDEs, and I think I would like theoretical physics if I were able to study it, but I am not interested at all in statistics. Linear Algebra was probably my favorite math class in high school. At W&M my favorite math classes have been 307, 311, 316, and 410 (Elements of Lie Theory). I enjoy studying mathematical systems in themselves; in Lie Theory, for example, I found it interesting to study the Lie-theoretic systems that were developed on their own without any reference to applications and seeing how much theory we could build given certain principles. For me, the most interesting fields in mathematics are those that allow us to study mathematical objects as they are. The enjoyment that I get out of mathematics comes from moving intellectually from a place where I do not understand these objects to a place where I have some deep or meaningful understanding of what they are doing. (This is probably less so actual ‘enjoyment’ than it is just a sense of satisfaction in having made myself understand something, or in proving that I am capable of understanding something. I know what it feels like to really ‘enjoy’ studying in other fields, and I do not get that same feeling from mathematics.)

For now, I am only interested in studying more pure math and seeing how deep of an understanding I can achieve in those fields. I would like to take more pure math classes after I graduate and potentially do research, but I am not sure that I will ever be good enough to do deep research in pure math.

When I took Linear Algebra at a community college in my senior spring of high school, I found that most of the other students in that class (maybe 60 school. I thought that was interesting.

- I started my math journey when I learned abacus at the age of 4. Then during primary school, I learned to use all kinds of complicated theories without proving them in competitions (at where I grew up, kids must do well in those competitions to get to a good middle school). That was when I found math is my favorite subject, because it is the only thing I don’t mind doing during summer breaks instead of going out and play. Later, I realized math is not entirely problem solving during high school when I learned calculus. I think that was the time I decided to study seriously and major in it at college, even though there wasn’t a time that I saw myself as any other major since I was a kid. I want to study math because I really like it. I enjoy the process of discovering or building a complicated world based on limited facts or axioms. The most inspiring course for me is mathematics modeling during high school,

where I changed my mind from pursuing pure math to applied math. The courses I like are calculus, ODE, Euclid/non-Euclidean geometry, and Math 424. I have not yet decided what I want to do with math. I will not become a mathematician, but my dream job must relate to mathematics in some ways.

- There were times when I wish to change my focus but none of them turned out to be well, so it is until my sophomore year when I decided to study math.

When I was a kid, I was taken to an extracurricular Olympic math course and I did pretty good in that class. Since then, math has always been one of my more competitive subjects.

I like math 430, the introduction to number theory. It is hard, but quite interesting. I have not yet decided my future career.

For me personally, it might be the reason of how I have been studying math in high school and elementary school, it is always easy for me to understand and use a theorem to calculate. But to use a theorem to prove another conclusion is quite a challenge. I think this is one reason that prevents me from further my study in pure math. In many circumstances I need to see how one theorem is used to get an actual result, in order to be fully capable to use it. I think that is why I enjoyed number theory so much.

- During my childhood, I have always excelled at playing cards by calculating probabilities. For example, my mother is a Mahjong master and I have learned many Mahjong techniques, so I outperformed my peers a lot in Mahjong and other card games as well. The more I won card games, the more I became obsessed with probability and statistics. Over time, card games have helped to hone my mathematical skills, and further contributed to my unrelenting passion for mathematics and statistics. My early foray into statistics soon expanded into a love for economics as well. After entering the college, I took advantages of the many liberal and art courses on offer and quickly realized found the perfect application of statistics to real-world problems in economics. As such, I pursued a double-major in Applied Mathematics and Economics. As a big fan of the NBA, I was deeply interested in comparing the statistics of different NBA players since I was young. In the course Statistical Data Analysis (Math 352) that I enjoyed a lot, I used R to run a stepwise regression with 7 independent variables. Through my NBA project, I realized that the importance of computational techniques and mathematical reasoning to putting statistical theories into practice and applying them to actual problems. Overall, these experiences have enhanced my statistical analysis skills. Importantly, it gave me a glimpse of the utility of statistical reasoning and theories to address real-world economic and business questions, which further cemented my interest in this area. Upon graduation, I will be pursuing a master's degree in business analytics at Columbia University. I am still not sure what to do after I graduate from Columbia but I am considering option like working as a data analyst or a quantitative trader.

3 Conclusion

It is interesting to hear all the different experiences and ‘stories’ of the participants. There are differences and similarities among the stories. In fact, some comments and experiences were also shared by other mathematicians. Many (almost all) participants did not decide to study mathematics seriously until they came to W&M. In fact, the instructor (CK) also did not decide to study mathematics until he went to college. Similar to some other participants, he has thought about study other subject, namely, Chinese, before he decided to major in mathematics, and subsequently pursue graduate study. Participants showed different interests in mathematics courses, which is quite natural. As times go by, one may see that both the pure and applied subjects will be useful in future study and careers related to mathematics. The favorite story of CK is: he did not like OR when he took the course in college, but his first research paper actually used the idea from the subject. Also, John Nash won the Nobel Prize in Economics based on the application of his work on Nash equilibrium in game theory to economics. But his exposure to economics was minimal. So, some courses or training may become useful later in one’s life quite unexpectedly.

It is nice to see that interesting mathematics courses and good instructors will have positive impact on students though different people may be attracted by different types of courses. The main distinction seems to be pure or applied subjects. Of course, the department / college should always improve the curriculum to provide best training to students. It is important to get input from students and also explain the intention of the design of the curriculum to students. Of course, some of the changes and plans are affected by the limitation of resources. Of course, it boils down to the optimization problem of making the best use of the resource to achieve the education goal.

With the mathematics training, one may consider many different careers as seen in the comments of the participants. As mentioned before, some people would decide to be a mathematician in very young age, and some would make the decision late. It is certainly a good idea to obtain more information and plan carefully before making a decision. Of course, it is a again an optimization problem!

References

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