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For the Love of Mathematical Research: A Conversation with Undergraduate Research Students

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Abstract

"One of my passions as a professor is creating opportunities for students to ask questions about mathematics."

Posting about students' perspectives on mathematics research from *In All Things* - an online journal for critical reflection on faith, culture, art, and every ordinary-yet-graced square inch of God's creation.

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Part 1 (of a 2-part interview conversation)

Undergraduate Research Students: Anika Homan and Jocelyn Zonnefeld

Introduction from Dr. Mike Janssen, Dordt mathematics professor

One of my passions as a professor is creating opportunities for students to ask questions about mathematics. There are many ways to do this in the classroom setting, but the purest form of mathematical inquiry is in the research process. It turns out that there are lots of reasonable, interesting, and impactful mathematical questions whose answers are still unknown, and more are asked each day.

I have had the pleasure of serving as a faculty mentor for seven students over four summer research projects, each supported by Dordt's Kielstra Center for Research and Grants. As mathematical explorers at a Christian university, we are given the opportunity to intentionally reflect on the nature of our work, seeking to integrate it into our understanding of Creation and our role in unfolding the Creation in response to the cultural mandate.

Over the course of our eight weeks this summer, my research students and I had a conversation about this process, what it was like, and how they believe it will impact them in the future. Below is a lightly edited version of our discussion.

MJ: *So, first, can you tell us a little bit about yourself? What led you to consider doing research this summer?*

AH: My name is Anika Homan, and I'm a mathematics major from Appleton, Wisconsin. At Dordt, I participate in cross country, track, and the Kuyper Honors Program. I was first led to consider doing research this summer through the encouragement of Dr. Janssen. Not only would I develop my mathematical skills and thinking, but I would also gain a glimpse into the field of higher mathematics. This was especially important to me as I'm exploring my post-grad goals. Plus, the idea of getting to spend my summer doing something I enjoy seemed like a pretty sweet deal to me!

JZ: My name is Jocelyn Zonnefeld, and I am a student at Dordt University with majors in mathematics, statistics, and data science. I am also in the Kuyper Honors Program and play

in chamber orchestra. One major influence that motivated me to consider research was the self-led aspect of the investigation. In a course, professors have an abundance of material to cover, so they need to keep moving forward through different concepts.

> While doing research, I am encouraged to stop and explore when I find something interesting. The increased flexibility allows for a deeper investigation of fascinating branches of mathematics.

MJ: *What has the research process been like? Has anything surprised you?*

JZ: In the course of my mathematical explorations this summer, I have found that research in mathematics requires a healthy combination of curiosity, skepticism, and mental resilience. When researching mathematics, I am looking to discover something new, so I need to be curious. As a mathematical explorer, I am building on the understanding of other mathematicians by wondering how I can use their knowledge to gain insight into something new. However, I also need to be skeptical of my own reasoning. In research, I must build a case for my conclusions through a mathematical proof, and my logic within that proof must be airtight. When writing these proofs, I have been surprised by the difficulty of conveying my thought processes. The rationale in the proof seems clear to me, but I often realize that others disagree. Research and proof-writing have certainly improved my ability to fully explain my understanding of a concept.

AH: To add to Jocelyn's response, the research process has been a rewarding, albeit challenging, endeavor. I committed days to investigating an idea or question, only to discover few results. Other times, however, I completed multiple proofs in a day. Consequently, the research process has taught me patience and persistence.

Something that surprised me about the research process was the level of independence we were granted. Jocelyn and I were truly given the freedom to focus on whatever facet of our research topic intrigued us. While Jocelyn and I were working together on the same topic, we spent most of our time investigating our own separate interests within that topic.

Furthermore, I was surprised by the wealth of ideas and directions of study that research can help uncover, even about a highly specific topic. During my first few days of research, I was left questioning how I could possibly fill the duration of my time with meaningful investigation. However, as Jocelyn mentioned, curiosity is vital in the research process. Once I looked into my first question, I soon discovered several other directions I could look into, which uncovered several more ideas of interest, and pretty soon I was left wondering how I would ever have enough time to look into everything I wanted to!

MJ: One of the things you've both hit on in your answers is the idea of exploration. However, I would guess that "exploration" is not a word that many people associate with their mathematical experiences. How has your research experiences changed or added nuance to the way you think about what mathematics *is*? Are there any ways you think your research experiences will impact your approach to future mathematics classes?

AH: My research experiences have caused me to view mathematics as more dynamic and interactive than I ever had before.

> Often there is a tendency to approach mathematics with blind acceptance: we use the formulas and theorems we are taught in class to solve our assigned homework problems, and we rarely go beyond that. However, my research experiences have allowed me to see mathematics as something so much deeper and mysterious. Mathematics isn't simply about performing calculations to arrive at the right answer to a problem. Mathematics is meant to be engaged with. It's about observation and pattern seeking.

Mathematics derives its power not only from describing the world around us, but also by its ability to completely remove itself from anything concrete. Mathematics is not just about recognizing patterns, but it's also about considering the "why" behind those patterns.

I think one of the greatest impacts of my research experiences is the practice of not being satisfied with merely recognizing a pattern or performing a calculation. In my future mathematics classes, I believe I will be more likely to ask questions such as: "Why is this theorem true?", "Why does this pattern occur?", "Why is this formula valid?" I will want to consider the reasoning behind the concepts we learn and find connections with the mathematics I have already been exposed to. Finally, I think I will be trained to look for new directions for future exploration.

JZ: I readily agree with Anika's sentiment about needing to know the "why" aspect of mathematics. In my experience, understanding the reasoning behind a concept in mathematics or any other area motivates a deeper knowledge of and appreciation for a given field. I have also found that research has shifted my perspective on the accessibility of mathematics. When I took classes, I always viewed the people who discovered theorems and new fields of mathematics as these lofty and revered intellectuals who are completely separate from me. In my mind, they make the rules and I play around with numbers within the confines of those rules.

> As I have researched mathematics, I discovered a freedom in realizing that I am capable of that research and exploration as well.

Mathematicians from the past were simply curious people that repeatedly asked "Why?", so we can take part in a small piece of their work by demonstrating that same curiosity.

I look forward to continuing to take more mathematics classes with the perspective that I am not simply a student but a fellow mathematician joining those before me as we seek to learn more about the world around us.