Why Pursue Graduate Studies in Mathematics? Insights Into Motivation From Personal Essays

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Deciding to pursue graduate study is a pivotal step in students' academic and professional trajectories. However, limited research exists on the motivations for applying to mathematics graduate programs. To address this gap, we analyzed 74 personal statements, in which applicants articulate their motivations, goals, and experiences, submitted as part of applications to master's and doctoral programs in mathematics and statistics at a mid-sized research-intensive university (2015–2024). Using qualitative coding with AI-assisted analysis, five key themes emerged: pursuit of knowledge, research aspirations, career advancement, growth as a teacher, and appreciation of mathematics. Most applicants expressed multiple, overlapping motivations, often linking professional goals to disciplinary growth and research. A distinctive finding was the prominence of appreciation of mathematics, where applicants described joy and fascination with the subject as central to their decision-making. These results expand understanding of mathematics graduate decision-making and carry implications for recruitment, advising, and program design.

Keywords: graduate studies in mathematics, motivation, personal essays, AI-assisted coding

The decision to pursue graduate education in mathematics is a significant milestone in an individual's academic and professional journey. While there is a growing body of literature examining motivations for graduate studies in general, much of this work has focused on broad patterns across disciplines or within professional fields, and relatively little is known about this decision-making process in the context of mathematical sciences. Previous research has identified both internal and external factors that shape an individual's decision to pursue an advanced degree. For example, individuals are often motivated intrinsically by intellectual fulfillment and self-satisfaction (Incikabi, 2013; Kowalczuk-Waledziak et al., 2017). External motivations include career advancement, prospects of financial gain, and job security (Hinkle et al., 2014; Ivankova & Stick, 2007). Mathematics-related graduate programs prepare individuals for diverse roles in academia, research, and industry, yet little research has examined the factors influencing students' decisions to apply to these programs.

This study seeks to address this gap by examining the personal essays written by applicants to graduate programs in mathematics and statistics at a mid-sized public university with a high level of research activity in the Northeastern United States. By analyzing how applicants articulate their motivations, goals, and aspirations, this research aims to provide deeper insights into the factors shaping students' decisions to pursue advanced mathematics degrees.

Literature Review and Theoretical Framing

Research on pursuing higher degrees is extensive across fields; however, fewer studies focus specifically on mathematics. This review first draws on the general literature on motivations for advanced study, then turns to factors shaping decisions to pursue graduate mathematics.

Motivations for Pursuing an Advanced Degree

Motivations for pursuing an advanced degree are multifaceted, shaped by both internal and external factors (Incikabi, 2013). Internal factors influencing the decision to pursue graduate

degrees often center on personal fulfillment, such as intellectual challenge, self-satisfaction, and a sense of achievement (Incikabi, 2013; Kowalczuk-Waledziak et al., 2017; Teowkul et al., 2009). Students are also often motivated by research interests and prior academic success (London et al., 2014; Wiegerová, 2016). Additionally, self-efficacy, influenced by both internal and external factors, is critical in this decision-making process. Positive self-efficacy—bolstered by support from faculty, peers, and family—strengthens confidence in one's ability to succeed academically and professionally (Gibbons & Schoffner, 2004; Sherman, 2021).

External motivations typically center on professional gain, career advancement, job security, and higher salaries (Hinkle et al., 2014; Ivankova & Stick, 2007; Ng et al., 2011; Teowkul et al., 2009). Advanced degrees are typically required for entry into academia and some industry fields (Basalla & Debelius, 2014). Hence, career alignment is a strong predictor of graduate enrollment (Tennant, 2004). Additionally, different social pressures, including family expectations, peer influence, and mentor encouragement, often shape the decision to pursue graduate education (Brailsford, 2010; Hinkle et al., 2014).

Factors Influencing the Decision to Apply to Graduate School in Mathematics

While the literature on pursuing graduate studies in mathematics is limited, previous research has shown that this decision is shaped by a set of academic, social, and structural influences. These influences interact with broader demographic and social dynamics—such as race, gender, and socioeconomic status—to shape who ultimately pursues graduate study in mathematics. For example, students from minoritized groups face financial barriers, such as application fees, and underrepresentation in mathematics departments, contributing to feelings of isolation (McEldowney et al., 2024; Posselt, 2016). Gender and socioeconomic status similarly shape opportunities and have been shown to encounter systemic challenges that limit access to graduate mathematics (de Brey et al., 2021; Nevill et al., 2007).

Institutional and relational factors also play a key role. For instance, students at research-intensive universities are more likely to pursue graduate study due to greater access to resources and research opportunities (Zhang, 2005), which strengthens confidence and research identity (Hathaway et al., 2002; Willis et al., 2013). Faculty mentorship, supportive advising, and inclusive teaching practices further encourage persistence and application to mathematics graduate programs (Blaney & Wofford, 2021; Mu & Fosnacht, 2019).

Methods

The primary data consist of personal statement essays submitted as a part of the application process for mathematics or statistics graduate programs at a mid-sized public research university in the Northeastern United States. These personal statements are carefully composed essays in which applicants articulate their motivations, long- and short-term goals, and relevant research or professional experiences, offering insight into the factors shaping their decision to pursue advanced study. To recruit participants, we contacted applicants from 2015 through 2024. For those who consented, the second author—who serves on the admissions committee and has access to applications from these years—extracted their statements along with background information on gender, year of application, program, and citizenship status. Race/ethnicity was an optional field on the application and could not be collected consistently for all participants.

Participants and Data Collection

The participant pool for this study comprised 74 individuals who submitted applications to graduate programs in mathematics or statistics during the academic years 2015-2024. The data

set includes applicants that fall into four groups: (1) current students at the university (N=14), (2) graduates of the university (N=11), (3) individuals whose application was rejected by the university (N=20), and (4) individuals who were accepted but chose not to attend or who started their studies but withdrew prior to graduation (N=29). The degree programs (referred here as "mathematical sciences") included both doctoral and master's programs in Applied Mathematics, Statistics, and Pure Mathematics, a doctoral program in Mathematics Education, and a Master of Science for Teachers (MST). The breakdown of the participants' data by program is specified in Figure 1 in the Results section. Out of these participants, 41 identified as male, 32 as female, and one did not specify. Additionally, 46 were U.S. citizens, 25 were not, two had dual citizenship (one of which was the U.S.), and one did not specify.

Data Analysis

We employed qualitative methods to identify applicants' motivations for pursuing graduate education in mathematics or statistics. The data analysis was completed in two stages: codebook development, followed by AI-assisted coding (Butler & Buchbinder, submitted; Dunivin, 2024), which aided in handling the large volume of qualitative data.

Codebook development. First, we manually developed a codebook of participants' reasons for pursuing advanced study in mathematics. The first author used open coding and the constant comparative method (Patton, 2002; Strauss & Corbin, 1998) to analyze a subset of 16 essays (21.6%) and generate preliminary codes for explicit and implicit motivations in the personal essays. These codes were refined into broader categories with clear definitions and illustrative quotations. This process yielded five themes: Knowledge Pursuit, Career, Research Aspirations, Growth as a Teacher, and Appreciation of Mathematics (Table 1).

Table 1: Thematic codes, definitions, and examples of applicant motivations.

Code	Description of Code	Example
Knowledge Pursuit	Applicants emphasize intellectual growth, expressing a desire to expand their mathematical understanding or develop specific skills, whether theoretical, problem-solving, or applied.	"Upon admission, my primary goals would be to understand the methods by which mathematics is applied and then utilize those methods in my study of physics."
Research Aspirations	Applicants describe motivations centered on engaging with the research process in graduate studies, such as designing studies, investigating questions, or contributing to scholarship.	"My immediate goal in continued graduate work includes gaining more research experience, as I currently have less experience than I would prefer."
Growth as a Teacher	Applicants aspire to become stronger educators, inspire students, address mathematical anxiety, or improve pedagogy. This code is more focused on instructional development rather than obtaining a teaching position.	"I want to get a PhD in Math Education to find techniques to assist a larger number of students to enjoy and appreciate the beauty of mathematics."
Career	Applicants explicitly tie graduate study to professional outcomes or a job goal, such as becoming a professor, researcher, or analyst.	"Becoming a professor has been a goal of mine for a long time, and that is the ultimate goal of getting a PhD for me."

Appreciation of Mathematics	Applicants express joy, fascination, or admiration of mathematics—highlighting its beauty, creativity, or elegance. Points to affective and aesthetic dimensions of engagement with the discipline.	"My biggest motivation for pursuing a graduate degree is my love and appreciation for mathematics. This subject has pushed me out of my comfort zone and has given me an outlet to demonstrate my creativity."

AI-assisted coding. Following the development of the initial codebook, an AI-assisted coding workflow was utilized (Butler & Buchbinder, submitted; Dunivin, 2024). For ethical considerations and in accordance with IRB approval, a temporary feature of ChatGPT was used. This means that the data was not used to train a large language model and is automatically erased from the system after 30 days. All essays were anonymized before the analysis. This use of AI was included in the participant consent form.

First, we designed a preliminary AI prompt, instructing AI to apply the codebook deductively to the 16 statements (21.6%) that the first author had already manually coded. We compared the AI-generated codes to the researcher's original codes. Based on the results, we corrected the prompt and reapplied it to the same data. This iterative process of prompt refining and applying to coded data continued until a satisfactory level of agreement between the human coder and AI was achieved, with a Cohen's Kappa of 0.83, representing a strong level of agreement (McHugh, 2012). With this level of intercoder reliability established, we applied the finalized prompt to have AI code the remaining personal statements with the five codes (Table 1). Then, the researcher blindly coded another 16 statements (21.6%) coded by AI and compared the results. There was almost perfect agreement between AI and manual coders, with a Cohen's Kappa of 0.89 (McHugh, 2012). In both manual and AI-assisted coding, each theme was counted only once per essay, regardless of how many times it appeared. This allows us to associate each applicant with the set of themes in their essay, and each theme with the number of applicants who mentioned it in their essay.

Results

Analysis of the 74 personal statements resulted in a total of 252 codes across all essays. On average, each essay was coded approximately three of the five codes, indicating that applicants typically cited multiple reasons for pursuing a graduate-level mathematics degree. All five themes were present across applicant types, degree levels, and programs, though the prevalence and emphasis varied. Results for each code in each major are represented in Figure 1. We turn now to summarizing each theme. Due to space constraints, the results section focuses on the context of each code across all essays rather than on detailed subgroup analyses.

Across the essays, the *knowledge pursuit* code was the most prevalent motivation (24.6% of total codes) across most programs, as shown in Figure 1, appearing in 62 personal essays (~84% of applicants). Some applicants with this code shared eagerness to deepen their theoretical foundations, often citing specific advanced coursework, such as abstract algebra, set theory, and analysis (e.g., "I would like to continue my education in Bayesian Statistics as well, which is one of the many reasons that I am seeking admission.") While other applicants framed their learning as open-ended exploration, curious about topics they had not yet encountered (e.g., "My long-term objectives are to expand my knowledge, likely in ways I have not yet imagined.") Overall, the knowledge theme highlights applicants' view of graduate study as an opportunity to expand and deepen their understanding of mathematics.

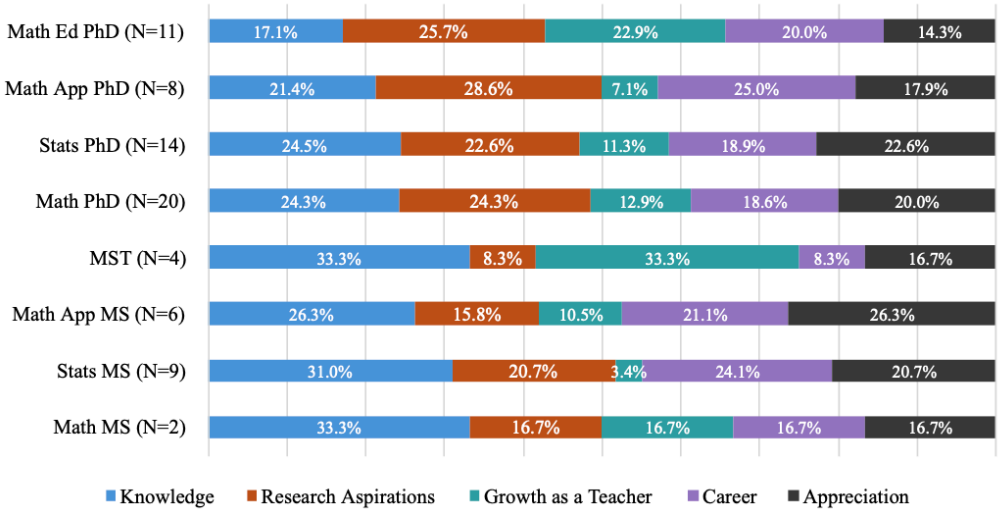

Figure 1: Distribution of codes by program (MS and PhD).

The next most common theme was *research aspirations* (22.6% of total codes), present in 77% of essays, but more prominent in doctoral applicants (Figure 1). Several applicants described a strong desire to engage in research in graduate studies, some referencing prior independent or guided projects and expressing intentions to continue such work in graduate school. For example, one applicant wrote, "I would very much like to continue research in mathematics." In contrast, others emphasized their goal of gaining new experience with research in a specific area, either emphasizing a broader ambition to contribute meaningfully to the field (e.g., "My long-term objectives are to discover and contribute to meaningful work and to do my best to offer something special to a field full of great thinkers,") or citing specific questions or area of interest. For example, one applicant stated:

> The experiences that I have from tutoring, teaching, and researching have sparked my interest in studying and seeking to improve math education. I am interested in answering questions like: Should the learning of probability and statistics be given more emphasis in high school? How can we improve students' mathematical discourse, in particular, oral communication? How much should we value our students' mathematical discourse? How can we improve students' mathematical reasoning?

Overall, this theme underscores applicants' curiosity and proactive engagement with mathematical inquiry.

In the personal essays, several applicants (~68%) also expressed a desire to pursue a graduate-level degree to achieve specific career goals. The *career* code captured applicants' descriptions of their long-term professional aspirations and represented 19.8% of the total codes. For example, one applicant wrote, "My long-term objective is to be a tenured professor of mathematics at a university so that I can conduct research alongside other mathematicians and encourage young people to engage with mathematics," implicitly highlighting how graduate study serves as a stepping stone toward this goal. Many applicants aimed for academic careers that combine research and teaching at the college or university level. Others emphasized particular fields they hope to enter and how the degree would equip them with the expertise needed to be successful (e.g., "This [MS in Statistics] will provide the foundation I need to contribute to development of soccer analytics.") Across essays, several applicants framed graduate school as integral to their broader professional goals, providing the skills, knowledge,

and experiences necessary to make meaningful contributions to their chosen field, as one applicant noted: "I firmly believe that a PhD program will enable me to delve deeper into the field, expand my knowledge, and become a successful university professor."

The *growth as a teacher* code appeared least frequently (13.1% of total codes) in applicants' personal statements, present in 44.6% of them, yet still represented in nearly half of the sample. Applicants with this code expressed a commitment to improving pedagogical practice, inspiring students, and addressing barriers such as mathematics anxiety during their graduate studies. Many reflected on past teaching experiences and the challenges they faced. For example, one applicant described the difficulty of motivating students who were held back by fear of mathematics:

> Over the years of teaching, the biggest challenge has been motivating the students to understand the lessons and see the importance of mathematics. I have seen many intelligent students who I know can be good with math but are afraid of math...I aim to find methods to reach as many students as possible. It is important to me to find teaching techniques to at least lessen the fear of math for those who are afraid.

Other applicants emphasized broader teaching goals, such as making mathematics more inclusive (e.g., "My personal teaching goal in all of my math courses is to make math accessible to all students.") Some focused on strengthening their own mathematical knowledge to better support students (e.g., "I believe [the MST program] will be beneficial for my students, in that I will have a deeper understanding of topics I present to them.") Overall, this theme was most prominent in Mathematics Education-focused programs (MST and Mathematics Education PhD), as seen in Figure 1. However, it was present across all programs, as many applicants viewed graduate study as an opportunity to develop as educators capable of creating supportive, engaging, and effective learning environments.

Similar to the career code, the *appreciation* code appeared in 67.6% of personal essays and accounted for 19.8% of total codes, across all program applicants (Figure 1). While many applicants discussed professional goals, several emphasized a deep, sustained enthusiasm for mathematics itself. They described formative experiences that sparked their interest in mathematics—from early problem-solving activities to noticing mathematical patterns in nature and art—highlighting the intellectual stimulation and challenges the discipline provides. For some applicants, this appreciation served as a core motivation for graduate study, as they explicitly linked their pursuit of graduate education to this passion (e.g., "My biggest motivation for pursuing a graduate degree is my love and appreciation for mathematics.") Others conveyed it more implicitly. As in one essay:

> I feel mathematics brings out some of the qualities I admire most in myself. I am captivated and thrilled by the constant challenge math provides and I experience a profound curiosity from within that demands the understanding of a concept, solving a problem, or writing of a satisfying proof.

These expressions of intellectual curiosity and motivation illustrate how a genuine appreciation for mathematics can drive applicants' decisions to pursue advanced study.

Discussion and Conclusion

This study provides insights into the under-researched topic of the motivations of individuals for pursuing graduate studies in mathematical sciences. Across 74 personal statements of individuals applying to master's and doctoral programs, five primary reasons for applying to graduate school emerged: Knowledge Pursuit, Research Aspirations, Career Goals, Growth as a Teacher, and Appreciation of Mathematics. These themes align with and extend prior research.

Consistent with existing literature, applicants' essays reflected both internal and external motivations. The prominence of *knowledge pursuit* and *research aspirations* suggests that mathematics applicants tend to frame their decisions around intellectual growth and scholarly engagement (e.g., Teowkul et al., 2009). *Research aspirations* as a reason for applying to graduate school was more prominent in PhD applications compared to master's, underscoring the appeal of academic research but also the differences in future professional trajectories (e.g., Wiegerová, 2016). As in other fields, *career* motivation was also frequently mentioned (Incikabi, 2013; Kowalczuk-Waledziak et al., 2017). However, in our study, the applicants often described career goals as integrally tied to knowledge pursuit and research aspirations rather than a stand-alone objective. Many applicants envisioned careers in academia, highlighting the link between mathematics graduate education and pathways into teaching and research (Tennant, 2004).

The theme of *growth as a teacher*, though less frequent, was apparent. Consistent with previous findings, applicants described a desire to improve their pedagogical practice (Kowalczuk-Waledziak et al., 2017). While this theme was most prominent among applicants in education fields, such as the Master of Science for Teachers and PhD in Mathematics Education, it appeared in applications across all disciplines, with the lowest being Statistics MS (Figure 1). Many individuals articulated a goal of addressing classroom challenges they had encountered in either formal or informal settings, and expressed a commitment to making mathematics more accessible. This suggests that for some applicants, graduate study is not only about advancing their own expertise but also about transforming their role as educators.

The novel emergent theme was a*ppreciation* of mathematics. Although prior research has identified intellectual curiosity (London et al., 2014; Teowkul et al., 2009) and personal fulfillment (Kowalczuk-Waledziak et al., 2017) as drivers of graduate study, these constructs only partially overlap with the present findings. Applicants who expressed appreciation often framed mathematics as a source of "beauty" and intrinsic value. This deep-seated passion frequently co-occurred with other motivations, indicating that research engagement and career planning are often interwoven with an enduring appreciation for the discipline itself.

Our findings help broaden understanding of applicants' decisions to pursue graduate degrees in mathematical sciences, showing that these decisions are driven by a complex interplay of reasons. Applicants view themselves as future professionals and members of a disciplinary community tied to knowledge, research, teaching, and appreciation of the field. Understanding these motivations can inform targeted recruitment, advising, and mentoring strategies. In practice, these results can guide admissions committees, advisors, and program designers by illuminating the values and aspirations students bring into their graduate studies.

Some limitations should be acknowledged. First, the dataset is drawn from a single mid-sized public research university, which may limit the generalizability of the findings across institutional contexts. Applicants' personal statements also reflect self-presentation strategies shaped by the admissions process; motivations expressed here may be idealized or selectively emphasized. Our study is ongoing, as we continue to investigate how these motivations differ across demographic groups and programs. Future research should also examine how these motivations shift as students progress through graduate school.

Additionally, we aim to understand the types of past experiences—whether positive or negative—described by the applicants in our study that shape their decision to pursue graduate studies in the mathematical sciences. Furthermore, investigating how mathematics identity interacts with these motivations may provide deeper insight into the pathways that lead students into advanced study in the discipline.

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