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Cover Memo

The purpose of this proposal is to convince secondary school and college educators as well as school boards that students will be more successful in their first college proof class if they are taught proofs in middle and high school. In order to teach students proofs, secondary school math teachers need to know how to teach proofs. The proposal suggests that current teachers receive training on how to teach proofs and that math education majors take classes on teaching proofs.

This proposal would likely be published in a mathematics education journal for math educators of all levels of education. The executive summary would likely be the abstract for the document. Educators would read this article because the struggle math majors have with proofs has always been a major issue. Overall, math educators are interested in making learning math easier for their students. However, some college math teachers believe that their students need to struggle with proofs to learn how to write proofs, and students who want to do well will put in the time and effort to so. Unfortunately, the time and effort required is immense and can cause students to neglect their other classes.

Most students do not have any experience with proofs before college except for some basic proofs from Geometry. They are taught that math is a computational subject. So, students who become math majors have excelled at number crunching, but once they begin their proof courses, they do very poorly. Students do not do well in their first proof classes because they have not been exposed long enough to proof writing strategies. As a math major at UMD, I have experienced this first hand, and I know that many of my peers feel the same way. However, while I do mention some details about the math program at UMD, I do not write specifically from my perspective.

I had some difficulty writing for my target audience. I am not sure if I wrote my proposal in a tone appropriate to my audience and for a scholarly journal. Additionally, I do not know my audience very well. I believe that my proposal needs to be read by school boards so that current teachers are trained how to teach proofs, but I am not sure if school boards would read this proposal in a journal.

Executive Summary

College math majors are not prepared for their first proof class. Colleges and universities recognize this problem and offer introduction to proof classes; however, these classes do not permit students enough time to internalize the proof methods and techniques necessary for success in their first proof class. Some students are exempt from these classes due to exceptional performance in computational classes putting them at risk for poor performance in their first proof class. In order to prepare students to write proofs in college, secondary school math educators should teach proofs. Additionally, school boards and college educators must ensure that these teachers are properly trained to do so. School boards need to provide current middle and high school teachers with continuing education classes on how to teach proofs. Math education majors will also need to be taught how to teach proofs. Some colleges and universities offer such classes, but they should be mandatory for the math education major. An early introduction to proofs will not only help college students do well in their proof courses but also enable all students to gain a greater appreciation and deeper understanding of math.

Proposal

Many students learn about proofs for the first time in high school Geometry. This exposure is minimal as the proofs are rudimentary, short two-column proofs on properties of triangles and other geometric figures. Students do not see proofs again until their college professors introduce computational processes with proofs to show why the processes are valid and produce intended results. Some students, even math majors, ignore the proofs because they know that they will not be tested on them or do not understand why they are relevant to the class material. Unfortunately, many math majors do not realize that they need to understand and write proofs to do well in their upper level math classes. Therefore, these students experience great difficulty in their first proof class, often to the point of failing the class and having to retake it.

Some colleges and universities provide introduction to proof courses to assist students in making the transition from computational classes to proof heavy classes. For example, the University of Maryland offers MATH 310 Introduction to Mathematical Proof to its math majors. The class is a major requirement and a prerequisite for MATH 410 Advanced Calculus I, which is considered the “watershed” coursed as it is the first class that provides students with a deep understanding of mathematical proofs. However, students may be exempted from MATH 310 if they receive A’s in Calculus III and Linear Algebra, two lower level computational courses, or B’s in the two lower level computational honors math classes. As a result, there are a number of students who do not take the introduction to proof class. Even though these students have demonstrated a high level of mathematical competence and ability, they have solely shown that they are quite capable of succeeding in computational classes, not proof classes. While many students benefit from the introduction to proofs class, some will never receive those advantages and instead experience greater difficulty in MATH 410. If other colleges and universities manage their introduction to proof classes like the University of Maryland, many students will fall behind and do poorly in their first proof class.

Even those who take courses like MATH 310 have trouble in their first major proof class. While the class is helpful and provides proof writing strategies, the class does not provide students with enough time to internalize them. Math majors have been successful in their computational classes because every math class they took before college focused on computations. These students have had a great amount of time to learn how to best study for exams and complete homework assignments on computational topics. Unfortunately, as proof writing and higher level mathematical thinking are new skills for these students, they are still figuring out what ways are best for them to learn proof writing and study for exams. So, despite having learned the proof strategies in the introduction to proof class, students have trouble identifying which strategies to use and employing them in classes like MATH 410.

Since students require more time to become comfortable with proofs, they should be introduced to them much earlier in their educational careers. To help students succeed in their proof courses, middle and high school math teachers should teach proofs in addition to computations. If students are introduced to proofs before they come to college, they will have already gained a great amount of experience with proofs and be better prepared for their proof classes. The students exempted from classes like MATH 310 will have a solid background in proofs and be less likely to fall behind in future proof courses.

Perhaps the introduction to proof class will be unnecessary as students will be comfortable enough with proofs that they can proceed to take harder proof classes. As a result, students will be able to pursue their interests in mathematics and other disciplines. Additionally, the resources college and university math departments provide for the class can be used elsewhere. On the other hand, the introduction to proofs course can be transformed into a class that helps students understand the how to write proofs at the college level.

Introducing students to proofs earlier in their mathematical education enables them to learn the reasoning behind computations. Many students become frustrated with math at a young age because they do not understand the computations they are performing. They give up trying to understand math and lose interest in the subject altogether. Introducing students to proofs in their middle and high school math classes will allow them to understand why computations are performed a certain way. Proofs may make math easier for students to learn. Therefore, proofs may encourage more students to pursue math in college. Teaching students proofs early on will enable them to see that math is exciting and more than just computations.

Teaching proofs in middle and high school math classes can only be accomplished if math teachers know how to teach and incorporate proofs in their classrooms. Perhaps current teachers are not teaching proofs because they are not knowledgeable enough about proofs or do not know how to. Existing teachers will need to receive training or additional education on how to teach proofs in the classroom.

Furthermore, undergraduates studying to be math teachers need to be taught how to teach proofs. According to Eric Knuth of the University of Wisconsin-Madison, “university mathematics professors . . . play [a] significant role in shaping teachers’ conceptions of proof.” The University of Maryland offers MATH 312 Mathematical Reasoning and Proof for Pre-Service Middle School Teachers to prepare aspiring math teachers to teach proofs in middle school math classes. Other colleges and universities should adopt similar classes and make them mandatory for their math education majors.

Reducing the difficulty student’s face in college proof courses is the responsibility of educational systems and school boards around the nation as well as the colleges and universities that train math teachers. It will take some time and effort to teach proofs in middle and high school classrooms, but it can be done. Once students begin learning proofs at an earlier age, they will be better prepared for college level proof courses. Additionally, students will learn the logic behind mathematics enabling them to understand the subject on a deeper level.

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