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Student attitudes towards proof before and after a proof-based linear algebra course [1]

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The Department of Mathematics has long-struggled with how to best teach proof techniques to mathematics majors (and I think we are not alone.) A number of years ago, the Department designed two courses: MATH 2001: Introduction to Discrete Mathematics, and MATH 3001: Analysis 1, to do the task. Students would learn basic proof techniques in MATH 2001 (where the material was more elementary) and could then reinforce these techniques in the more advanced MATH 3001.

We noticed to our chagrin, that despite our efforts, many students were still not entering MATH 3001 well-prepared to produce and understand proofs. The Department confronted this problem by working with a DAT (departmental action team) from the Center for STEM Learning (CSL). The Solomonic advice of the DAT was to split our linear algebra course in two: creating a more numerical version (MATH 2130) for non-majors, and a proof-based version (MATH 2135) for math majors. This latter is for majors to take in between taking MATH 2001 and MATH 3001, to better prepare them for the latter by building on the material from the former.

I was one of the teachers piloting the new MATH 2135 course last Fall, and in class we had frequent discussions about HOW to prove things, and WHY to prove things, and indeed what it is that mathematicians DO. It would be helpful to know if (1) the course improves student attitudes about proofs, and (2) whether there is any correlation between attitudes and performance in the course, measured in terms of test scores. Indeed, if there is a positive correlation, we would have a real pedagogical reason to focus on attitudes.

It would also be good to pilot a more inquiry-based approach to the course, and then see if such a course does a better job of improving student attitudes. If it does, that would give us good impetus for investing the departmental effort necessary to make all sections of the course use an active-learning format.

CU Boulder is an innovator in the development of surveys of student attitudes in the STEM fields. PhET and PER@C developed an instrument called CLASS (Colorado Learning Attitudes About Science) and researchers at CU Boulder and the University of Nebraska modified it to form a survey called CALCS (Collegiate Active Learning Calculus Survey) to gauge student attitudes about mathematics, which we give to our precalculus and calculus students. I'm planning to adapt CALCS by adding questions specifically geared to test students' attitudes about proofs.

For source material, I plan to adapt question from survey instruments developed by Dr. Eric Knuth to measure student conceptions of proof. Knuth earned his PhD in education at CU Boulder 20 years ago, and I learned of his work by serving on his dissertation committee. He

has gone on to a career at Wisconsin and Texas, and I thank him for graciously agreeing to share his instruments with me.

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