

The Teaching and Learning of Geometric Proof: Role of the Teacher

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The purpose of this study was to explore preservice and novice secondary mathematics teachers' proof-writing abilities and beliefs about geometry (particularly proofs), in order to propose ideas about how to improve the teaching and learning of geometric proofs. This study contributed to the pre-existing research on Shulman's (1986) categories of teachers' knowledge. Although many studies distinctly examined subject matter content knowledge, pedagogical content knowledge, or curricular knowledge, the present study began to examine these factors in conjunction. Moreover, the researcher did not find pre-existing studies focusing solely on the beliefs, attitudes, and content knowledge of pre-service and novice secondary mathematics teachers with regard to geometric proof.

I created a five-item content assessment (eMATHinstruction, 2017, 2018a, 2018b; The University of the State of New York, 2015, 2016) to administer to preservice and novice secondary mathematics teachers. Each content assessment item was taken from end-of-year assessments for high school students. I met with 29 participants to administer the assessment while asking questions regarding their feelings, beliefs, and confidence in regard to teaching proof in high school geometry. The administrations of these content assessments and simultaneous interviews were audio-recorded and transcribed, and subsequently analyzed for trends in the participants' responses using five qualitative codes: Beliefs and Attitudes (BAA), Issues of Correspondence Between Substance and Notation (ICSN), Expressing Understanding and Self-Doubt (EUSD), Mathematical Language (ML), and Pure Mathematical Issues (PMI).

The results of the study showed that the majority of the preservice and novice secondary mathematics teacher participants do not currently feel prepared to teach proof in high school geometry, from standpoints of both mathematical content knowledge and confidence. The participants with no geometry teaching experience mainly drew on their own experiences from high school, and tried to remember specific rules and standards that their particular teachers tried to instill. This finding supports the ideas of Schoenfeld (1985) and Battista (2009), who also found that most secondary school students see proof-writing as nothing more than following a set of prescribed rules. This study, however, also illuminated issues within participants' Mathematical Knowledge for Teaching (MKT). Specifically, participants did not connect the ideas of rigid motions and equality of measures to congruence, used circular reasoning, and made incorrect visual assumptions when considering diagrams. In response to the interview questions that addressed participants' beliefs and feelings about proof and proving, the participants overall voiced preferences to teach other courses over geometry. Many participants gave up without attempting one or more content assessment items, displaying the need for stronger beliefs in their own abilities. Although participants were not told that the assessment items were high-school level problems, many of them expressed that they knew that from previous exposure via tutoring or student teaching.

Since teachers' attitudes are so easily transferrable to the students in their charge, it is important to continue to conduct research in this area so that the state of the teaching and learning of geometric proof can be improved.

References

- Battista, M. (2009). Highlights of research on learning school geometry. In T. V. Craine & R. Rubenstein (Eds.), *Understanding geometry for a changing world: Seventy-first yearbook* (pp. 89–108). National Council of Teachers of Mathematics.
- eMATHinstruction. (2017, August). *Common core geometry, unit assessments—Unit #2—Form A*. <https://www.emathinstruction.com/wp-content/uploads/2017/08/CCGeo.Unit-2-Assessment.Form-A.pdf>
- eMATHinstruction. (2018a, November). *Common core geometry, Unit #3—Euclidean triangle proof and constructions*. <https://www.emathinstruction.com/wp-content/uploads/2018/11/CCGeo.Unit-3.Additional-Triangle-Proof-Day-2.pdf>
- eMATHinstruction. (2018b, February). *Common core geometry, unit assessments—Unit #9—Form A*. <https://www.emathinstruction.com/wp-content/uploads/2018/02/CCGeo.Unit-9-Assessment.Form-A.pdf>
- Schoenfeld, A. H. (1985). *Mathematical problem solving*. Academic Press.
- Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4–14. <https://doi.org/10.3102/0013189X015002004>
- The University of the State of New York. (2015, August 12). *Regents high school examination: Geometry (common core)*. <https://www.nysedregents.org/geometryre/815/geomcc82015-exam.pdf>
- The University of the State of New York. (2016, January 28). *Regents high school examination: Geometry (common core)*. <https://www.nysedregents.org/geometryre/116/geomcc12016-exam.pdf>