# EXPLORING HIGH SCHOOL STUDENTS' VALIDATION METHODS IN THE MATHEMATICAL MODELING PROCESS

Ayse Ozturk
The Ohio State University
ozturk.25@osu.edu

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Calls have been made for the need to understand and advance students' mathematical modeling behaviors (Cai et al., 2014). Validation is a crucial step of the modeling process that occurs when modelers compare their mathematical results to a real-world situation that they attempt to understand (Blum & Leiß, 2007), and helps them to decide whether the model needs revisions or fulfills the need of the problem (Zawojewski, 2013). In this study, I investigated how high school students evaluate and validate their models in the mathematical modeling process.

The framework for this study stems from the two integrated theoretical stances—embodied cognition perspective (Lakoff & Núñez, 2000) and cognitive mathematical modeling perspective (Kaiser, 2017). Students' model-based problem-solving is influenced by their internal resources (i.e., mathematical knowledge and beliefs) (i.e., Stillman, 2011) and external relationships with the environment and other individuals (Lesh & Doerr, 2003). Prior experiences might be difficult to communicate at times for students, but linguistic tools can be rich with representational elements (Kövecses & Benczes, 2010) that can be turned into a validation method in the mathematical modeling process (Czocher, 2018). As a result, students embody experiences, intuitions, and means to support transfer through language, thought, and action while engaging cognitive steps of the mathematical modeling process (Manouchehri & Lewis, 2017).

This research was a qualitative, descriptive account of the validation ways employed in the mathematical modeling problem-solving process by eight high school students from different grade levels (2 ninth-graders, 2 tenth-graders, 2 eleventh-graders, and 2 twelfth-graders). Each participant completed 4 interviews lasting approximately 1 hour each based on one-on-one think-aloud tasks (Ericsson & Simon, 1998) at a public university in a Midwestern state. The selection of the participants was deliberate, targeting variability in mathematical backgrounds and self-efficacy toward solving mathematical problems. The common requirement of the interview tasks was choosing and interpreting quantity units and defining appropriate quantities to create descriptive models while using both mathematical knowledge (i.e., estimation) and non-mathematical knowledge to solve problems. Each interview was audiotaped and transcribed. The ongoing data analysis focused on the categorization of the forms of reasoning employed by the students while they were evaluating and validating their models, and then deciding whether their mathematical models needed more revisions or not. A content analysis of the transcripts (Patton, 2002) was used to detect themes in the students' validation methods.

The preliminary findings provided evidence in support of two of the themes identified by Ferri (2006)—*knowledge-based validation* and *intuitive-based validation*—and described three additional validation elements of implementation that appear to support those identified two themes: *formalistic validating* (the focus is on abstraction, formulas, mathematical correctness), *realistic validating* (the focus is on references to real situations that are enriched with verbalized or visual representations), and *formalistic–realistic validating* (the focus is on a balance between formal mathematical aspects and reality-based aspects of the problem).

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