

Exploring the Relationship Between Language and two Problem Types

Molly Stern
Teachers College, Columbia U.

Anthony Zhang
Teachers College, Columbia U.

Esther Issever
Teachers College, Columbia U.

Nicholas Wasserman
Teachers College, Columbia University

Paul Christian Dawkins
Texas State University

Keywords: Problem types, Language, Mathematics register, Mathematical domains

Much of the study of mathematics is reducible to the problems students are asked to complete. We are thus motivated to explore the language within problems – which would be part of the mathematics register (Halliday, 1975; Pimm, 1987) or even its own genre (Bakken & Andersson-Bakken, 2021). Yet, whereas mathematical terms are often both well-defined and consistently used, the language used for posing mathematical problems – our interest – is neither.

In a previous RUME report, Wasserman and Dawkins (2025) elaborated 8 problem types. In that preliminary theoretical paper, two common problem types across K-16 mathematics were noted as distinct, yet at times difficult to differentiate. SOLVE problems were about producing “the complete solution set of mathematical objects that satisfies a given set of properties” and EVALUATE problems were “the outcome of a procedure or operation” (p. 1023). The first might be understood as a search for particular elements in set builder notation, e.g., $\{x \mid +(5,x)=12\}$; the latter as the output of a function, e.g., $+(5,7)$. This proposal reports on work that further explored these two categories of problems in relation to the language used to pose them.

Methodology

Specifically, our work was guided by the following research question: “What, if any, linguistic features mark and distinguish prototypical SOLVE and EVALUATE problems across K-16 mathematics textbooks?” Five coders worked on the project. After discussing the two problem types, each selected a different elementary, middle, high school, and college textbook; and each added about 75 problems per book, from its breadth, that they felt could be unambiguously categorized as either SOLVE or EVALUATE. Coding then included the “problem stem” – often an imperative verb (e.g., Find), though sometimes an interrogative (What is) – and the problem type, along with some other basic information (e.g., grade level). Next, the research team coded each other’s problems, with disagreements being adjudicated or problems being removed as ambiguous. The result was a collection of ($n=915$) problems across K-16 that the five coders could unambiguously code as either SOLVE or EVALUATE.

Findings and Implications

From this work, we briefly share three claims (data supporting them, and others, will be shared on the poster): i) Some verb stems were distinctly associated with a problem type, e.g., “Add” and “Compute” were EVALUATE whereas “List” and “What are” were SOLVE, and other common verb stems like “Find” and (interestingly) “Solve” may have been either type of problem; ii) Two-verb structures (e.g., Use... to determine...) were primarily EVALUATE; and iii) Grade level impacted the distribution of problem types as well as particular verb stems.

We see this work as valuable because it informs how we might clarify to students the nature of a mathematical problem – either as SOLVE or EVALUATE – by incorporating specific linguistic choices into how we pose it.

References

- Bakken, J., & Andersson-Bakken, E. (2021). The textbook task as a genre. *Journal of curriculum studies*, 53(6), 729-748.
- Halliday, M.A.K. (1975). Some Aspects of Sociolinguistics. In, *Interactions between linguistics and mathematics education* (pp. 64-73). UNESCO.
- Pimm, D. (1987). *Speaking Mathematically: Communications in the mathematics classroom*. London, UK: Routledge and Kegan Paul.
- Wasserman, N., & Dawkins, P. (2025). Conceptualizing language for mathematical problem types across domains. In S. Cook, B. Katz, and K. Melhuish (Eds.), *Proceedings of the 27th Annual Conference on Research in Undergraduate Mathematics Education (RUME)* (pp. 1021-1026). Alexandria, VA: RUME.