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Rearranging equations for Physics reasoning; Implications for Physics Teaching and Learning

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Oral presentation

Abstract

Researchers generally agree that physics experts use mathematics in a way that blends mathematical knowledge with physics intuition [1]. However, the use of mathematics in physics education has traditionally tended to focus more on the computational aspect (manipulating mathematical operations to get numerical solutions) to the detriment of building conceptual understanding and physics intuition [2]. Several solutions to this problem have been suggested; some authors have suggested building conceptual understanding before mathematics is introduced [3], while others have argued for the inseparability of the two, claiming instead that mathematics and conceptual physics need to be taught simultaneously [4]. Although there is a body of work looking into how students employ mathematical reasoning when working with equations, the specifics of how physics experts use mathematics blended with physics intuition remain relatively underexplored. In this presentation, we describe some components of this blending, by analyzing how physicists perform the rearrangement of a specific equation in cosmology. Our data consist of five consecutive forms of rearrangement of the equation, as observed in three separate higher education cosmology courses. This rearrangement was analyzed from a conceptual reasoning perspective using Sherin's framework of symbolic forms [5]. Our analysis demonstrates how the number of potential symbolic forms associated with each subsequent rearrangement of the equation decreases as we move from line to line. Drawing on this result, we suggest an underlying mechanism for how physicists reason with equations. This mechanism seems to consist of three components: narrowing down meaning potential, moving aspects between the background and the foreground and purposefully transforming the equation according to the discipline's questions of interest. Finally, we discuss how being aware of the components of this underlying mechanism can potentially affect physics teachers' practice when using mathematics in the physics classroom and demonstrate a proposed teaching sequence, based on our findings.

References

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