



# Returning Voice to the 'Silent M':



## A Review of Conceptions of Mathematics in Integrated STEM education

Erin E. Baldinger, Sue Staats, Lesa M. Covington Clarkson, Elena Contreras Gullickson, Fawnda Norman, and Bismark Akoto

### Motivation and Research Questions

- Mathematics may actually be the least deeply integrated of the four disciplines (English, 2016; Fitzallen, 2015).
- The role of mathematics in integrated STEM teaching and learning remains unclear, understudied, and misunderstood.
- Mathematics is mainly a tool used for solving a science or engineering problem (Frykholm & Glasson, 2005; Walker, 2017).

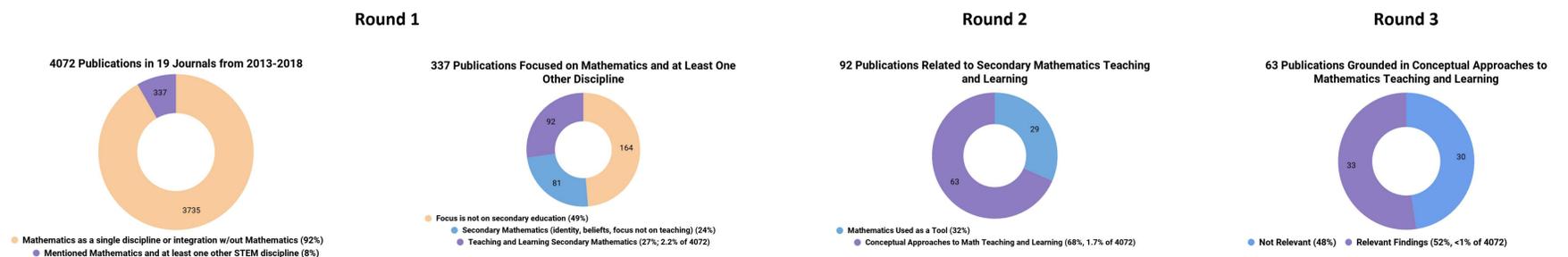
#### Research questions

- 1) What conceptions of mathematics are evident in the literature on integrated STEM education?
- 2) How has the role of mathematics been defined in the context of STEM integration?

### Methods

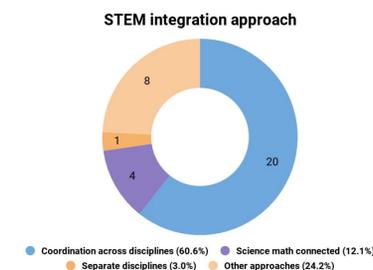
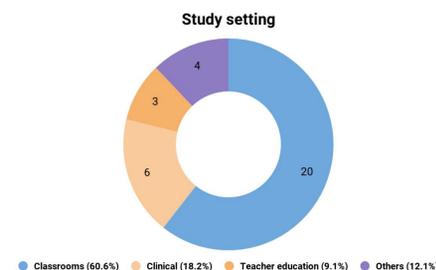
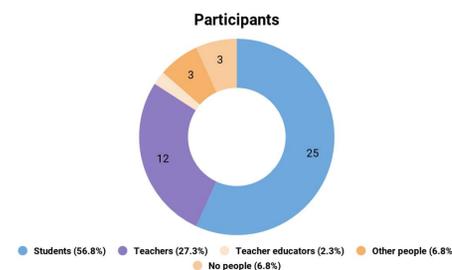
Conducted a brief review of 4072 articles published between the years 2013 to 2018 from 19 peer-reviewed journals that include research on STEM education in one or more of the STEM disciplines.

After three rounds of coding, we were left with 33 publications with findings related to the role of mathematics in integrated STEM education.

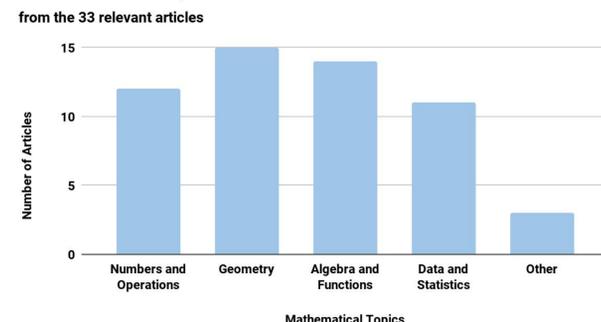


### Findings from the 33 Relevant Publications

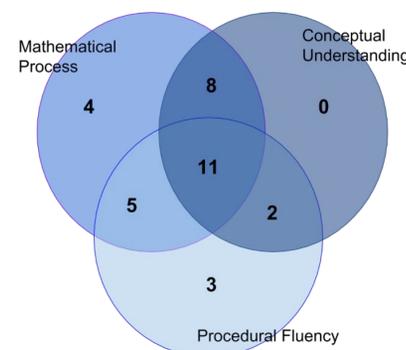
- Participants across the publications were mostly students and teachers.
- Most of the research took place in classroom settings.
- Integration mostly occurred through coordination across STEM disciplines.



#### Mathematical Topics



The mathematical content of the articles we reviewed was distributed fairly evenly across content areas. This suggests multiple spaces for mathematics to occur within integrated STEM education



- 23 articles either did not address procedural fluency at all, or did so only alongside both conceptual understanding and mathematical process. We highlight this result not because we feel that attention to procedural fluency should be avoided. Rather, we feel it is particularly important to address procedural fluency in the context of other strands of proficiency
- Overall, these results highlight that among these 33 articles, researchers are approaching mathematics learning with attention to multiple strands of proficiency

### Themes and Recommendations

Themes from the relevant articles:

- Mathematical communication and engagement in mathematical practices
- Authentic tasks as the context for doing mathematics
- Inquiry-focused approaches to teaching and learning
- Settings outside of traditional or formal teaching and learning spaces
  - summer school (Kwon, 2017)
  - hospital (Nickels & Cullen, 2017)
  - web-based competition (Jacinto & Carreira, 2017)
  - community spaces (Wilson-Lopez et al., 2016)
  - museum (Popovic & Lederman, 2015)

Our recommendations:

- Researchers should identify mathematics teaching and learning goals within their integrated context and further use the mathematical strands of proficiency (NRC, 2001) as a guide to support a more accountable approach to mathematics.
- Researchers should follow the example of Popovic and Lederman (2015) in seeking to identify authentic mathematical tasks within the integrated STEM context.
- Researchers should not limit their focus on mathematics teaching and learning to formal educational spaces.
- STEM integration can be done and, to be impactful, it must be done on a much larger scale.

References, including relevant publications

