Emulating Social Aspects for Argumentation in Non-STEM Classrooms

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Studies have described accountable argumentation (Horn, 2008), collective argumentation (Brown, 2017), or dialogic argumentation (Hähkiöniemi et al., 2022) for how students can engage with each other to develop rigorous mathematical reasoning. Argumentation, justifying, and proving often come together for students when mathematical proof is not the focal point of instruction (Knuth et al., 2022). A common theme for developing proof is the idea of convincing oneself and another (Yopp et al., 2022). This often entails another person asking for further details or justification about how a mathematical claim is true. For a non-proof-oriented classroom, the idea of a convincing argument is tenable for the development of proof (Czocher & Weber, 2020). Therefore, our research purpose was to investigate how students interact with increasingly socially constrained tasks.

Methods

We developed four tasks to explore emulating the social aspect for convincing another classmate. Each task provided varying social constraints. These tasks were implemented throughout one semester on the exams of three instructors in an introductory mathematics course for non-STEM majors. The first task was "show that the sum of two even numbers is even." The second task was "convince a very stubborn classmate that when you add two even numbers, your result will be an even number. This classmate is not convinced that this is true for every number, especially very large numbers." The third task was like the second but added "This classmate has **challenged** you to show that this is true without using specific examples" at the end. The fourth task was "show that when you multiply two even numbers, the result is even."

We coded the students' responses using deductive argument (DA; akin to a mathematical proof, justifies inferences, or a teacher would accept this), example use with attention to generality (EG; example use with connections to conclusion or references shared characteristics across mathematical objects), example use only (EO; only calculations), other argument (OA; doesn't fit the other types), and non-argument (NA; unclear intentions or irrelevant).

Results and Discussion

In general, among the 46 students who participated in at least one task, EO and OA were the most common response types. For the constrained second and third tasks, the frequency of EO codes decreased, indicating it is possible these constraints interacted with argument constructions. While only one student was coded DA, many OA or EG responses contained ideas of such an argument, so the task variations may motivate deductive reasoning. Of the 42 students who completed at least two tasks, 25 students varied in responses across tasks. Students responded differently to the constraints; for example, several students who started with EO responses later constructed arguments such as OA or EG and vice versa (i.e., OA or EG to EO). Given that over half of the students changed their response type, we argue that studying what students attend to when choosing their argumentation strategies is worthwhile. In future work, we intend to conduct student interviews to focus on how they interpret these constraints.

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References

Brown, S. A. (2017). Who's there? A study of students' reasoning about a proof of existence. *International Journal for Research in Mathematical Education*, *3*, 466-495.

Czocher, J. A., & Weber, K. (2020). Proof as a cluster category. *Journal for Research in Mathematics Education*, *51*(1), 50-74.

Hähkiöniemi, M., Hiltunen, J., Jokiranta, K., Kilpelä, J., Lehesvuori, S., & Nieminen, P. (2022). Students' dialogic and justifying moves during dialogic argumentation in mathematics and physics. *Learning, Culture and Social Interaction*, *33*, 1-12.

Horn, I. S. (2008). Accountable argumentation as a participation structure to support learning through disagreement. *Journal for Research in Mathematics Education. Monograph*, *14*, 97-126.

Knuth, E. J., Zaslavsky, O., & Kim, H. (2022). Argumentation, justification, and proof in middle grades: A Rose by Any Other Name. In K. N. Bieda, A. Conner, K. W. Kosko, & M. Staples (Eds.), *Conceptions and consequences of mathematical argumentation, justification, and proof* (pp. 129-136). Springer International Publishing.

Yopp, D. A., Ely, R., Adams, A. E., & Nielsen, A. W. (2022). Proof in the context of middle grades: can we label middle school arguments as proof with a capital P? In K. N. Bieda, A. Conner, K. W. Kosko, & M. Staples (Eds.), *Conceptions and consequences of mathematical argumentation, justification, and proof* (pp. 109-127). Springer International Publishing.