Observation Protocols as Research Tools for Video-Based Analyses of Undergraduate Calculus Recitations

Lauren Sager
University of New Hampshire

Rebecca Butler
Virginia Commonwealth University

Keywords: Observation protocol, active learning, classroom observation

Active learning is broadly recommended as an instructional approach for improving student outcomes in undergraduate mathematics classes (Smith & Funk, 2021). However, some research suggests little active learning is being implemented, leading to questions about how time is spent in these classrooms (Ellis et al., 2014). To address this, observation protocols have been developed that categorize instructor and student actions over time. Classroom Observation Protocol in Undergraduate STEM (COPUS) (Smith et al., 2012) and Toolkit for Assessing Mathematics Instructors – Observation Protocol (TAMI-OP) (Hayward et al., 2021) are two such protocols meant to describe actions taken in classrooms, especially to identify those using active learning methods. While these tools are typically utilized as a means of professional development and in evaluation processes, less is known about how they can function as analytic tools within the research process. We address the application of these observation protocols to mathematics education research, asking: What are the affordances and challenges of applying the TAMI-OP and COPUS protocols to undergraduate mathematics classroom video recordings from a research perspective?

This data comes from a larger NSF-funded study on active learning in introductory STEM courses at a medium Northeastern University. Here, we focus on Calculus recitation sessions which are led by a graduate teaching assistant (GTA) and supported by an undergraduate learning assistant (LA). The classroom recordings were selected from two semesters of recordings from the same GTA, used for a case study on the GTA's changes in classroom actions (Sager et al., 2024). The recordings were then coded using both COPUS and TAMI-OP by both authors. Any discrepancies were resolved by discussing until a consensus was reached. In COPUS and TAMI-OP, codes can be analyzed by calculating the percentage of 2-minute time intervals in which the code was marked, or as the percentage of a specific code is marked out of the total codes marked. We provide both computations to illustrate the different perspectives each of these protocols brings to the same dataset.

From our analysis, we show that COPUS and TAMI-OP can both be valuable research tools, but each has strengths that highlight distinct aspects of classroom interactions. TAMI-OP emphasizes questioning and answers, with multiple options to count types of questions and answers. We suggest it is advantageous for research aiming to capture the type of conversation or instruction in a classroom. Alternatively, COPUS tends to show an outline of actions taken in the classroom, making it more suitable for research settings focused on the overall actions occurring. For example, if an instructor begins class with a 10-minute mini-lecture, the first 5 intervals in COPUS may be coded with *lecturing* and *posing questions* for the instruction, while TAMI-OP additionally provides a number and type of questions and answers in each interval, thus giving some information regarding the nature of student participation during this time.

Our work illustrates how these observation protocols can be appropriately adapted as research tools and how each provides different perspectives on active learning in undergraduate mathematics classrooms. We encourage future researchers to apply these protocols to additional contexts in order to further explore the role they can play in the research process.

Acknowledgments

This research was supported by the National Science Foundation, Award No. 2013427. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

Ellis, J., Kelton, M. L., & Rasmussen, C. (2014). Student perceptions of pedagogy and associated persistence in calculus. *ZDM*, *46*, 661-673. https://doi.org/10.1007/s11858-014-0577-z

Hayward, C. N., Laursen, S. L., & Weston, T. (2017). *TAMI-OP: Toolkit for assessing mathematics instruction – observation protocol.* Boulder, CO: University of Colorado Boulder, Ethnography & Evaluation Research

Lund, T..J., Pilarz, M., Velasco, J.B., Chakraverty, D., Rosploch, K., Undersander, M., & Stains, M. (2015). The best of both worlds: Building on the COPUS and RTOP observation protocols to easily and reliably measure various levels of reformed instructional practice. *CBE Life Sciences Education,* 14, 1-12.

Sager, L., & Butler, R. (2025). Enacting active learning in calculus: How one graduate teaching assistant's instruction shifted with an experienced learning assistant's support. In Cook, S., Katz, B. & Melhuish, K. (Eds.). *Proceedings of the 27th Annual Conference on Research in Undergraduate Mathematics Education*. Alexandria, VA.

Smith, M.K., Jones, F.H.M., Gilbert, S.L., & Wieman C. (2013). The classroom observation protocol for undergraduate STEM (COPUS): A new instrument to characterize university STEM classroom practices. *CBE Life Sci Educ* 12, 618–627.

Smith. W. M., & Funk. R. (2021). The student engagement in mathematics through an institutional network for active learning project: An overview. In W. M. Smith, M. Voigt, A. Ström, and W. G. Martin (Eds.) *Transformational change efforts: Student engagement in mathematics through an institutional network for active learning* (Chapter 1, pp. 26-41). American Mathematical Society and Mathematical Association of America Press, and the Conference Board of Mathematical Sciences.