INSTRUCTORS, MENTORS, AND STUDENTS: A CROSS-COMPARISON OF PERCEPTIONS OF STUDENT-CENTERED INSTRUCTION

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Forty-two novice collegiate mathematics instructors (CMIs) who were being supported in their use of student-centered techniques through a peer-mentoring program provided data about their use of such techniques during their teaching. The students in their courses and their mentors also provided data about their perceptions of the CMIs' implementation of student-centered instructional techniques, specifically around Student Engagement, Teaching Facilitation and Lesson Design factors. Results suggest that novice CMIs tended to overestimate their use of student-centered techniques within each of these factors compared to mentor-provided observation data and student-provided survey responses. Students, however, tended to report fewer instances of student-centered techniques than their instructors but more instances than that recorded by the mentors.

INTRODUCTION

Ineffective teaching methods in introductory mathematics courses are prominent reasons that undergraduate students give for deciding not to pursue degrees in science, technology, engineering, and mathematics (STEM) disciplines (President's Council of Advisors on Science and Technology, 2012). In US doctorate-granting colleges and universities, non-tenure track faculty, adjunct faculty, or mathematics graduate student instructors often teach these courses. These collegiate mathematics instructors (CMIs) typically employ the same exposition-centered methods from which they themselves learned mathematics, despite the fact that these methods have been shown to be less effective for learners (Seymour & Hewitt, 1997). By contrast, student-centered techniques are highly correlated with improved student-learning outcomes (Freeman et al., 2014). In this study, researchers provided professional development for novice CMIs and examined to what extent they facilitated student-centered teaching while teaching undergraduate mathematics courses and being mentored by experienced, trained, peer CMIs. More specifically, the purpose is to compare the peer-mentors', novices', and undergraduate students' perceptions of these teaching practices in the CMIs' classrooms.

BACKGROUND LITERATURE

Assessing instructional practices in STEM courses can utilize various methods, each with their own advantages and disadvantages (American Association for the Advancement of Science, 2013). Two commonly used methods in studies of collegiate mathematics classrooms are observations and surveys. Observational data collected by a neutral third party is considered more objective than survey data because self-reported data is prone to subjective bias (Ebert-May et al., 2011). However, constraints when conducting observations include reliability, variability, and time/cost concerns (Hill, Charalambous, & Kraft, 2012). This leads to the query: Can researchers substitute a survey for observations to increase the number of participants involved while decreasing time and costs invested?

In efforts to address this question, some studies in the collegiate STEM context (e.g., Ebert-May et al., 2011) and in the K-12 context (e.g., Fung & Chow, 2002) found that instructors' self-assessments of their use of student-centered instructional techniques overestimated the extent to which interactivity and active-learning was a feature of their classroom. However, in collegiate STEM classrooms studied by Smith and colleagues (2013), there was alignment between the faculty members' self-awareness of how often they used methods related to lecturing and presentation and what was observed. To limit 'inaccuracy' or 'bias' in self-reporting by CMIs, classroom observation data can be triangulated using aligned instruments calibrated for student and mentor (third party) perceptions. Hence, bringing in the students' and mentors' perceptions of the class can help us better understand differences between observations and CMI self-reported data. We explore the question: *From well-aligned instruments, how do observation data, instructor self-report, and student surveys agree/disagree with one another?*

METHOD AND CONTEXT OF STUDY

Researchers at three universities in the US designed and implemented a peer-mentoring program to support CMI use of student-centered techniques. Participants included 42 novice graduate student instructors, a subset of CMIs, with limited teaching experience who were assigned to teach introductory mathematics courses. Through this program, novices were mentored for at least one semester by one of 11 trained mentors, for one or two semesters dependent upon teaching assignments. Each semester, each mentor was grouped with four novices teaching the same course and observed each novice at least three times. Following each observation, mentors completed the Graduate Student Instructor Observation Protocol (GSIOP; Rogers, Petrulis, Yee, & Deshler, in press) and provided feedback in a one-on-one conversation with the novice about strengths and areas of improvement.

Three Factors from the Graduate Student Instructor Observation Protocol (GSIOP)

Drawing from the Mathematical Association of America's (MAA) Instructional Practices Guide (2018), to help CMIs develop effective instructional practices, the GSIOP focuses on three factors: Lesson *design practices* (DP), *teacher facilitation* (TF), and classroom practices that promote *student engagement* (SE). To help CMIs structure their lessons to engage students in high-level thinking and reasoning, DP includes lesson planning around explicit, measurable, goals; designing mathematical activities aligned with their goals; and communicating instructional decisions and mathematical connections to students. When CMIs have created lessons with activities intended to engage students in mathematical meaning making, they also need to effectively implement the lesson, involving TF. The GSIOP is designed to support CMIs' facilitation of mathematics tasks by documenting various aspects of TF (see Gleason, Livers, & Zelkowski, 2017). Further, CMIs can help students retain information through SE in meaning making. Specifically, "students need to actively engage in the process of learning mathematical ideas, developing strong conceptual understanding, and using these ideas to develop procedural fluency" (MAA, 2018, pp. 10 & 63). We record SE as whether or not students engage with peers, mathematical ideas, varying strategies, and formative assessment.

Data Collection and Analysis

Mentors used the GSIOP during observations of novices throughout the semester and novices and instructors provided survey responses at the end of each semester. The 17 items on the GSIOP were aligned with questions on student and CMI surveys. To compare responses from the three instruments,

we used data drawn from 190 GSIOPs, 42 novice survey responses, and 253 undergraduate survey responses. We combined data from multiple GSIOPs and multiple undergraduate survey responses for each novice in each semester. We took the average of the observation ratings on each item, as well as preserving the rating of the final observation for each novice in each semester.

We grouped undergraduate survey responses by novice and semester and computed the mean score on each item for each novice/semester combination. Each novice received a mean of 6 student-survey responses each semester. We compared novice and undergraduate survey responses to GSIOP data on relevant items. If a GSIOP item was aligned with more than one survey item, item responses were averaged. To compare the data, means for each item on each instrument were categorized as *low*, *medium*, or *high* based on the specific scales used in the different instruments and the general distribution of response data. Creating these categories made it possible to compare consistency of responses across instruments and examine how the GSIOP and survey data were similar to one another.

RESULTS

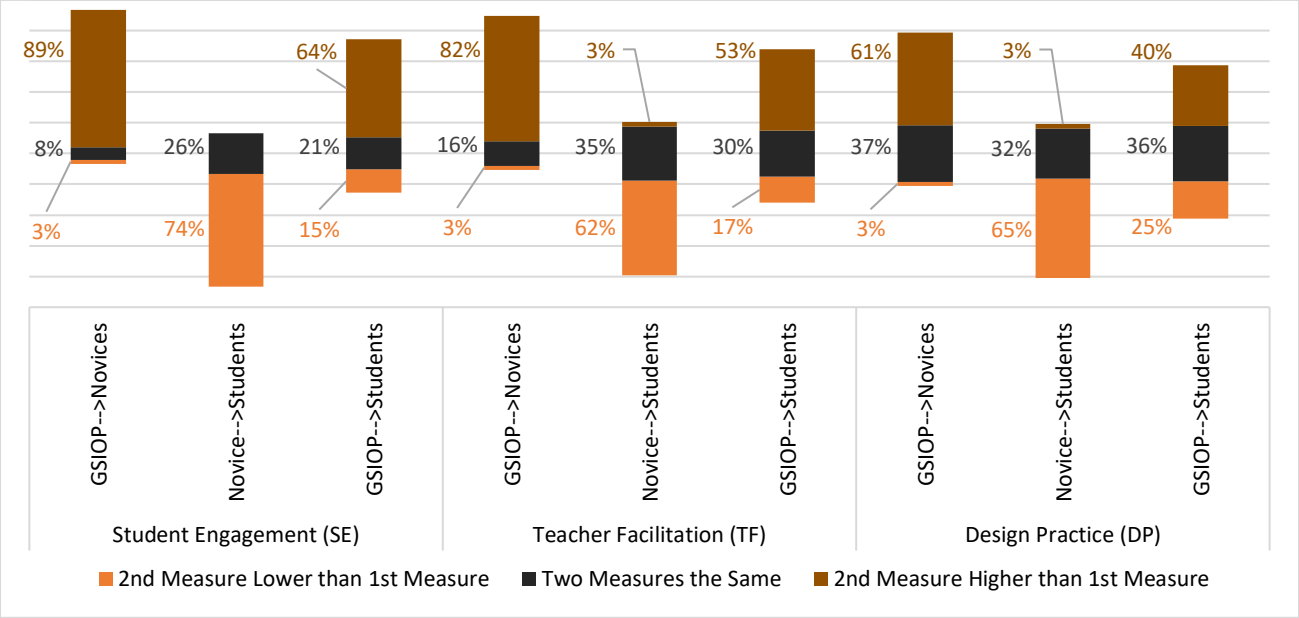

Figure 1. GSIOP, Novice Survey, and Undergraduate Survey Alignment

We considered the alignment of each individual GSIOP item with corresponding items on the surveys of novices and undergraduate students. Novices tended to give themselves higher scores than the GSIOP (mentor) or the undergraduates, and there was much less difference between GSIOP scores and undergraduate survey responses. Building on the factor analysis of the GSIOP (see Rogers et al., in press), we reanalyzed the data relative to the SE, TF, and DP factors. We combined the category scores of items related to each of these three factors (Figure 1). These results depict the same pattern as the individual item analysis—novices tending to rate themselves more highly than either the GSIOP or the undergraduates. The combined results for each factor emphasize this comparison (Figure 1).

DISCUSSION

Novices in this study tended to self-report that they were facilitating more student engagement in their design of and implementation of mathematics lessons than the undergraduate students in their classes experienced (this self-report overestimate is similar to some earlier results described, Ebert-May et al.,

2011; Fung & Chow, 2002). The nuanced perspective this study includes, however, is that of the undergraduate students' perspective. Results indicated that mentor's observations tended to report less frequent teacher facilitation and student engagement practices than students reported. We take this to mean that mentors were more critical of novices' implementation of student-centered practices than students were. Since the mentor is positioned to speak directly to the novice's development as a teacher, these results could guide the type of feedback mentors prioritize with novices. Perhaps starting with specific suggestions from the DP factor (because student responses were more in alignment with GSIOP results) might be an area where novices could more quickly make small changes and after experiencing success they might be more willing to try new things in the TF or SE categories. Also, since novices tended to overestimate their effectiveness and confidence in implementing student-centered techniques, sharing the results from GSIOPs or student surveys during a semester could be fertile ground for informing novices' professional growth.

ACKNOWLEDGMENT

This work was supported by collaborative National Science Foundation (NSF) grants (#1725264, 1725295, & 1725230). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the NSF.

References

American Association for the Advancement of Science [AAAS]. (2013). *Describing and measuring undergraduate STEM teaching practices.* Washington, DC: Author.

Ebert-May, D., Derting, T. L., Hodder, J., Momsen, J. L., Long, T. M., & Jardeleza, S. E. (2011). What we say is not what we do: Effective evaluation of faculty professional development. *BioScience, 61*(7), 550-558.

Gleason, J., Livers, S., & Zelkowski, J. (2017). Mathematics classroom observation protocol for practices (MCOP2): A validation study. *Investigations in Mathematics Learning, 9*(3), 111–129.

Freeman, S., Eddy, S., McDonough, M., Smith, M., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, 111*(23) 8410–8415.

Fung, L., & Chow, L. P. (2002). Congruence of student teachers' pedagogical images and actual classroom practices. *Educational Research, 22*(3), 313-321.

Hill, H. C., Charalambous, C. Y., & Kraft, M. A. (2012). When rater reliability is not enough: Teacher observation systems and a case for the generalizability study. *Educational Researcher, 41*(2), 56-64.

Mathematical Association of America [MAA] (2018). *Instructional Practices Guide*. Washington, DC: Author. Retrieved from https://www.maa.org/sites/default/files/InstructPracGuide_web.pdf.

President's Council of Advisors on Science and Technology [PCAST]. (2012). *Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics* (Report to the President) (p. 103). Washington, DC: Office of the President.

Rogers, K. C., Petrulis, R., Yee, S., & Deshler, J. (in press). Mathematics graduate student instructor observation protocol (GSIOP): Development & validation study. *International Journal of Research in Undergraduate Mathematics Education*.

Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving*. Boulder, CO: Westview Press

Smith, M. K., Jones, F. H., Gilbert, S. L., & Wieman, C. E. (2013). The classroom observation protocol for undergraduate STEM (COPUS): A new instrument to characterize university STEM classroom practices. *CBE- Life Sciences Education, 12*(4), 618-627.