Development of the Undergraduate Mathematics Class Attributes Questionnaire

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Understanding instructional dynamics in post-secondary mathematics requires tools that capture both classroom complexity and students' lived experiences. Existing instruments such as EQUIP (Reinholz & Shah, 2018), WIHIC (Dorman, 2003), and X-PIPS-M (Creagar et al., 2022; Street et al., 2021; Walter et al., 2016) have advanced research on teaching environments by assessing discourse, engagement, and collaboration in the classroom environment. However, these tools often prioritize researcher-defined metrics over student perspectives, leaving critical gaps in equity-focused analysis. Melhuish et al. (2025) caution that observation-based measures risk reinforcing dominant cultural norms, framing "good teaching" through whiteness and middle-class values unless marginalized voices are centered. They advocate for QuantCrit-informed redesigns that embed cultural responsiveness and intersectionality to ensure validity.

Additionally, observation protocols like EQUIP provide insights into classroom discourse but fail to capture out-of-class learning spaces such as homework and study groups, creating blind spots in understanding student experiences. To address this, we are developing the Undergraduate Mathematics Class Attributes Questionnaire (UMCAQ), grounded in the Instruction as Interactions framework (Cohen, Raudenbush, & Ball, 2003) and informed by Hiebert and Grouws' (2007) definition of teaching as interactions around content. By integrating participatory equity (Reinholz & Shah, 2018; Shah & Lewis, 2019), UMCAQ shifts from measuring what happens to exploring how it feels and for whom, positioning equity as a guiding principle in instrument design.

Pilot Study – Item Selection

In spring 2025, we conducted a pilot study with 197 students enrolled in four undergraduate mathematics courses (Calculus I, n = 39; Calculus II, n = 54; Differential Equations, n = 76; and Intro to Proof, n = 28), with the intent of exploring item sensitivity to section-level differences related to instruction. At the section level, groups ranged from small (2–8 students) to large (up to 17 students), providing variability to examine section-level differences.

For each of the 37 items included in the pilot study, which were derived from both extant classroom surveys and investigator developed items, we looked for the response patterns to find items with low variance. To examine section-level sensitivity in student perceptions, we employed cumulative link mixed models (CLMM) using the ordinal package in R, which is well-suited for ordinal data such as Likert-scale responses. We fit two complementary models for each UMCAQ item. The first model specified the course section as a fixed effect and the course as a random intercept, allowing us to directly test whether differences between sections were statistically significant while controlling for course-level clustering. The second model treated the courses and sections as nested random intercepts, providing variance components for both levels and enabling computation of Intraclass Correlation Coefficients adapted for ordinal outcomes. This hierarchical specification captured the proportion of variance attributable to course and section differences without imposing fixed-effect assumptions. This poster invites attendees to explore opportunities for collaborative development and adaptation of UMCAQ, ensuring that diverse student voices shape the future of mathematics education research.

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