Factors Affecting Students' Mathematical Affect: Layered Analysis

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Introductory mathematics courses are a critical juncture in undergraduate students' STEM trajectories. Unfortunately, these courses often erode students' *mathematical affect* – their attitudes and beliefs about their relationship to mathematics – reducing success and persistence (Ellis et al., 2016; McLeod, 1992; Rainey et al., 2018). We set out to better understand, at scale, what aspects of students' experiences influence changes in students' mathematical affect while enrolled in introductory courses by answering the following research questions: (1) What factors influence students' reported change in mathematics affect across a term? (2) What influences students' *reports of those factors*, when in the same classroom?

Data for this poster comes from a large set of precalculus and calculus student responses from 21 universities. The survey covered students' experience in their course, academic and personal identity, beliefs about themselves and mathematics, and more (Apkarian et al., 2019). Of particular relevance to this study, these included both retrospective and introspective questions about students' mathematics affect, which were compared to create the composite variable *change in math affect* (ΔMA); items about instructional practices were transformed using principle component analysis and oblimin rotation into composite factors (Jolliffe & Cadima, 2016). We leveraged *least absolute shrinkage and selection operator* (LASSO) regression analysis methods to answer both research questions. We used 10-fold cross-validation to train the model on 80% of the, reserving 20% for testing. LASSO creates a parsimonious, interpretable model by penalizing the absolute size of regression coefficients, dropping less important models out of the model by forcing their coefficients to zero. We select the model with the fewest variables following the "one-standard-error rule," a conservative approach which further reduces overfitting (Hastie et al., 2009).

To answer RQ1, we employ LASSO with the outcome variable ΔMA and 15 input variables, including demographic characteristics and reports of classroom practices (*N*=22,923). In this model (MAE=0.74; HL=0.45; R^2=0.21), the only variable whose coefficient does not shrink to zero was *MathENG*, a composite variable measuring students' reported engagement in meaningful mathematics. MathENG exhibits wide variance, even among students enrolled in the same course, leading us to specify the second research question as: *What influences variation in students' reports of MathENG within the same course?*

To answer RQ2, we employ LASSO regression with the outcome variable *MathENG_cen*, a recalibration of students' responses centered around the mean response of their classmates, modeling how 12 variables relate to students reporting higher/lower MathENG than their peers (*N*=23,201). Factors which did not disappear from this model (MAE=0.58; HL=0.22; R^2=0.03) are gender (negative impact on women vs. men); major (positive impact on STEM majors vs. non-STEM majors); and reports of how class time was spent (positive association with class discussion; negative association with listening to the instructor lecture and solve problems).

The poster will further detail the model and fit characteristics and explore conjectures, implications for research and practice, and next steps needed to further understand these phenomena.

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