

Calculus Students' Mindsets are Not So Simplex

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Keywords: mindsets, growth mindset, metacognition, calculus, topological analysis

In Psychological Meaning System Theory, *mindsets* are attitudes that people hold about themselves (Dweck, 2000). Traditional studies on mindsets are rooted in psychological methodologies, relying on surveys, questionnaires, and psychometric scales. While these tools give researchers initial insight into the mindset phenomenon, due to their nature, they also prime participants to think about specific mindsets in isolation. To study mindsets from a different methodological perspective, Hensley & Gilroy (2025a, 2025b) analyzed the differences in how Calculus I students' mindsets manifest over a semester depending on students' first exposure to a Calculus course (high school or university) using data collected from short reflective prompts during an actual Calculus course. Results suggested that students who took Calculus in high school tend to exhibit different mindsets than those taking it in college for the first time.

In Topology, an intuitive definition of a *simplicial complex* is a space with a triangulation (Weisstein, n.d.), which is useful for modeling the structure of multi-dimensional combinations of objects. Each simplicial complex contains a variety of sub-dimensional objects; a vertex is zero-dimensional, an edge is one-dimensional, a filled-in triangle is two-dimensional, a solid tetrahedron is three-dimensional, and so on. The purpose of this study is to revisit the coding results from Hensley & Gilroy (2025a, 2025b) and to conduct a novel analysis of the mindsets exhibited by students who were "successful" in Calculus I. We defined "success" as those earning a final grade of "A" ($n = 31$) or "B" ($n = 28$). For each student, we assigned a "mindset simplex." For each of Units 1, 2, 3, and 4, we constructed a simplicial complex that modeled each student's combinations of mindset codes. Then, we tabulated the frequency of simplices in each unit whose vertices represented productive mindsets (growth, mastery, strategic, and curious), non-productive mindsets (fixed, helpless, non-strategic, and non-curious), and mixed mindsets (at least one productive and at least one non-productive mindset). We note that the mindset simplices are similar to the Code Co-Occurrence Model produced by software like MAXQDA (*Code Co-Occurrence Model*, n.d.). Viewing these combinations of mindsets through a topological lens allows for them to be viewed in higher dimensions.

We calculated the relative frequency of the types of simplices (productive, non-productive, and mixed): first, on the aggregated data, then disaggregating initial frequency tabulations by gender, final grade earned, and first setting of Calculus, and comparing between groups. We saw the largest differences between students who first saw Calculus in a high school (HC) setting versus a university setting (CC). CC students had higher proportions of strictly productive mindsets than their HC counterparts.

This provides further evidence of the conclusions in Hensley & Gilroy (2025a, 2025b) that these two groups of students exhibit different mindset profiles, implying that they experience a typical general Calculus I course very differently. Furthermore, it may be advantageous for instructors to consider these differences when teaching the course. An extended version of this writing with figures can be accessed at <https://tinyurl.com/MindsetSimplex>.

References

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