Through the Eyes of Expertise: Decoding Mathematical Cognition with Eye-Tracking and Entropy

Maribel Viveros
University of California, Merced, Reedley, California, United States

Zenaida Aguirre-Munoz PhD
UC Merced, Merced, California, United States

Abstract

Understanding how experts and novices allocate visual attention during mathematical problem-solving can reveal novel insights into cognitive processing. This study investigates eye-movement patterns in linear algebra tasks using entropy and recurrence quantification analysis (RQA). Eye-tracking data were collected from participants of varying expertise levels, analyzing fixation duration, scan paths, and pupillometry between key Areas of Interest (AOIs). Results indicate that experts exhibit lower entropy, suggesting a more systematic, targeted approach, whereas novices display higher entropy, reflecting exploratory and less efficient search strategies. A Welch Two-Sample t-test confirmed significant differences in entropy scores, with experts showing greater attentional focus in key areas. These findings highlight the role of visual attention in mathematical cognition. Our research underscores the potential of entropy-based metrics for assessing problem-solving strategies, with implications for content sequencing and designing instructional tools that scaffold visual attention in STEM education.

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