Interdisciplinary Aspects of Linear Algebra: Student-identified Applications in STEM

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Motivation and Research Questions. Linear algebra bridges abstract mathematical principles with advanced applications across diverse STEM fields (Stewart et al., 2022). Students often perceive its concepts as disconnected from their fields of study to their disciplines (Stewart et al., 2019). This study investigates: What is the nature of discipline-relevant examples identified by students at the beginning of an applied linear algebra course?

Literature and Theory. Existing literature highlights the importance of linear algebra in solving real-world problems across STEM and beyond. Stewart et al. (2019) emphasizes the need to connect abstract concepts like matrices and eigenvalues to practical applications, while Muhammad & Saidi (2024) demonstrate its role in data science through tasks such as dimensionality reduction and predictive modeling. Wang (2019) and Arangala (2023) emphasize the relevance of conceptual understanding in fields like machine learning, engineering optimization, and cryptography. Beyond STEM, linear algebra's applications in areas such as digital art and forensic psychology showcase its versatility (Stewart et al., 2022). This study aims to enhance teaching strategies that bridge theory and practice.

Data Sources and Methods. We analyze online discussion board responses from 66 U.S. undergraduate linear algebra students, grouped into five major-area categories: Applied Mathematics, Biomathematics, and Mathematics Education; Computer and Computational Science; Mechanical, Electrical, and Biomedical Engineering; Statistics, Actuarial Science, and Economics; and Non-STEM majors. Early in the term, students were asked to identify an example problem from their area of study that uses linear algebra. Data-driven codes capture the range of examples students provided (deCuir-Gunby et al., 2011). Examples provided by students were classified as Q&A (when a specific question and sample solution was provided, illustrative examples (when a demonstration of a particular idea was provided), or for descriptions of broad ideas (general principle in their discipline was provided). Examples were further analyzed for dimensional context (low or high) and core linear algebra concepts.

Results and Discussion. The representation of majors in our sample of 66 student responses was: Applied Mathematics (~16.67%), Computer Science (~24.24%), Industrial Engineering (~19.70%), Statistics and Actuarial Science (~34.85%), and non-STEM majors (~4.55%). The majority of responses were coded as Q&A (~39.29%) or illustrative examples (~44.64%), with about (~16.07%) coded as broad ideas. High-dimensional examples accounted for 62.5% of responses, prevalent in Computer Science and Statistics, while low-dimensional examples were more frequent in non-STEM fields and Engineering. The most frequently cited topics included Matrix (35 mentions, ~20%), matrix operations (29 mentions, ~16.5%), and eigenvalues (23 mentions, ~13%), with significant overlaps observed between disciplines. For instance, optimization techniques connected Engineering and Computer Science, while transformations bridged art and non-STEM applications. These patterns varied within and across disciplinary clusters, reflecting both shared and unique applications of linear algebra concepts. In our poster, we will feature a selection of examples across majors and linear algebra topics to highlight trends in dimensionality issues and overlap of discipline specific knowledge and linear algebra in endeavors focused on student selected topics.

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