
STEAM-BASED ETHNOMATHEMATICS FOR LINEAR ALGEBRA LEARNING: A CULTURAL HERITAGE APPROACH USING DIGITAL BREAD STAMPS IN ENGINEERING EDUCATION

Cristina M.R. Caridade^{1,2*}, Verónica Pereira^{1,2},

¹*Polytechnic University of Coimbra, Coimbra, Portugal*

²*inED – Center for Research and Innovation in Education, Polytechnic University of Coimbra, Coimbra, Portugal*

ABSTRACT

This paper examines the integration of cultural heritage and digital technology in Higher Education through an innovative STEAM-based project-based learning (PBL) intervention [1, 2]. Implemented within a first-year Linear Algebra course for Biomedical and Electromechanical Engineering students, the project titled "Marking the Bread in the Digital Communal Oven" addresses the abstract nature of vector spaces and matrix operations [3]. It uses traditional Portuguese bread stamps (pin-tadeiras or cunhos), historically documented in ethnographical collections, as a conceptual framework for teaching matrix transformations [4]. The pedagogical methodology followed a three-phase design: ethnographic analysis, mathematical modelling, and computational implementation [2, 4]. Using computational tools such as MATLAB, GeoGebra, and Generative AI, students translated the physical geometric patterns of historical bread stamps into digital matrices. This approach allowed them to visualize and execute geometric transformations, such as reflections, rotations, and dilations, by directly manipulating matrix equations. Quantitative and qualitative analysis ($n = 51$) demonstrated high student academic achievement and engagement, with a significant majority developing positive perceptions toward mathematics [3]. By connecting ethnomathematics with modern computational software, the intervention successfully transformed abstract algebraic structures into meaningful, tangible engineering applications [1, 2]. The study concludes that embedding local cultural heritage within STEM curricula enhances students' spatial reasoning, improves conceptual understanding of linear transformations, and fosters a sense of regional identity and social responsibility among future engineers [4].

Keywords Linear Algebra · STEAM Education · Cultural Heritage · Matrix Transformations · Generative AI · Ethnomathematics · Higher Education · Project-Based Learning · Engineering Education.

References

- [1] Aruvee, E., Vintere, A. Contextualizing mathematical learning in real-world problems to improve motivation and self-efficacy. *Journal of Engineering Education*, 42(1), 15–28, 2023.
- [2] Caridade, C., Pereira, V. Matrices in motion: An educational journey through the universe of linear algebras, processes, and problems. In *INTED2025 Proceedings, IATED*, 6310–6320, 2025.
- [3] Wijnia, L., Noordzij, G., Arends, L. R., Rikers, R. M., Loyens, S. M. The effects of problem-based, project-based, and case-based learning on students' motivation: A meta-analysis. *Educational Psychology Review*, 36(1), 29, 2024.
- [4] Yi, X., Chua, K. H., Mohd Fadzil, H. The Implementation and Challenges of a Project-Based STEM Programme in Rural Minority China. *Canadian Journal of Science, Mathematics and Technology Education*, 26(2), 30, 2026.

*Corresponding Author's E-mail: caridade@isec.pt