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Proof-of-Concept Learning LLC

Vision: Guide mathematics learning by making connections between cognition, assessment, and artificial intelligence.

Summary

Mathematics cognition and AI-in-education researcher with 20+ years of experience spanning learning progressions, automated item generation (AIG), assessment design, and AI evaluation. Former Senior Research Scientist at ETS; current founder of an independent research consultancy. Expertise includes prompt engineering, generative AI content evaluation, experimental design, and statistical analysis (R, SPSS). Principal Investigator on NSF grants totaling over $6.4M, with additional experience as Co-PI and Senior Personnel on federally funded projects (NSF, IES) totaling more than $8M altogether.

Skills

AI in Education: Prompt engineering; evaluation of AI-generated mathematical content; automated item generation (AIG) with LLMs; error taxonomy development for AI reasoning systems
Programming & Statistical Software: R, SPSS
Research Design: Experimental design; data analysis and statistics; learning progressions; proposal writing
Assessment Design: Design of innovative, engaging mathematics assessment tasks
Leadership & Mentorship: Led major federal grants with multiple subrecipients; mentored interns and early-career professionals
Communication: Experienced author and presenter; facilitator across mathematicians, learning scientists, psychologists, assessment specialists, psychometricians, and software developers

Employment History

Founder — Proof-of-Concept Learning LLC 2026–present

- Educational research consulting at the intersection of cognition, assessment, and artificial intelligence.

Senior Research Scientist — ETS 2020–2025

- Learning progressions, mathematics learning, AI evaluation, automated item generation.

Research Scientist — ETS 2004–2020

- Contributed to the CBAL Research Initiative, learning progressions, competency modeling, automated item generation.

Associate Research Scientist — ETS 2001–2004

- Automated item generation.

Research Scientist — University of Washington, Seattle — Dept. of Psychology 2000–2001

Education

Ph.D. in Cognitive Psychology; Minor in Quantitative Psychology 1992–2000

University of Washington, Seattle — Dissertation: *Designing a Computer Tutorial to Correct a Common Student Misconception in Mathematics*

Bachelor of Arts in Mathematics 1992–2000
University of Washington, Seattle
Bachelor of Arts in Psychology; Minor in Biological Sciences 1988–1992
Binghamton University, Vestal

Grants

Principal Investigator — National Science Foundation 2021–2025

- *Investigating the Role of Collaboration on the Development of Student Ideas using a Learning Progression for the Function Concept.* Grant #2101393. Budget: $3,063,630.

Principal Investigator — National Science Foundation 2016–2021

- *Development and Empirical Recovery for a Learning Progression-Based Assessment of the Function Concept.* Grant #1621117. Budget: $3,350,056.

Senior Personnel — Institute of Education Sciences 2017–2020

- *DAT-CROSS: Developing Assessments and Tools to Support the Teaching and Learning of Science Crosscutting Concepts.* Grant #R305A170634. Budget: $1,395,722.

Co-Principal Investigator — National Science Foundation 2003–2006

- *Adaptive E-Learning for Middle-School Mathematics.* Grant #0313202. Budget: $399,996.

Featured Publications

Graf, E. A., Shin, H. J., Yan, D., & Von Davier, A. A. (2026). Automated item generation: The promises and the challenges. In *Reference module in social sciences*. Elsevier. https://doi.org/10.1016/B978-0-443-26629-4.00236-7

- Reviews traditional and AI-assisted approaches to automated item generation (AIG), presents a revised workflow contrasting the two, and includes a worked example comparing AI-generated items to human-authored items psychometrically, plus a discussion of agentic AI for AIG.

Graf, E. A., van Rijn, P. W., & Eames, C. L. (2021). A cycle for validating a learning progression illustrated with an example from the concept of function. *The Journal of Mathematical Behavior*, 62, 100836. https://doi.org/10.1016/j.jmathb.2020.100836

- Proposes and refines a four-step validation cycle for learning progressions (theory development, empirical recovery, comparison to competing models, evaluation of instructional efficacy), illustrated using the function concept.

Graf, E. A., & van Rijn, P. W. (2015). Learning progressions as a guide for design: Recommendations based on observations from a mathematics assessment. In S. Lane, M. R. Raymond, & T. M. Haladyna (Eds.), *Handbook of Test Development* (2nd ed.). Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9780203102961-11/learning-progressions-guide-design-edith-aurora-graf-peter-van-rijn

- Discusses how learning progressions can guide the design of classroom mathematics assessment, drawing recommendations from applied observation.

Graf, E. A., & Fife, J. H. (2012). Difficulty modeling and automatic generation of quantitative items: Recent advances and possible next steps. In M. J. Gierl & T. M. Haladyna (Eds.), *Automatic Item Generation* (pp. 157–179). Routledge. https://www.ets.org/research/policy_research_reports/publications/chapter/2013/jgkb.html

- Reviews difficulty modeling and AIG research for quantitative items and argues for an iterative design-evaluation-revision approach linking cognitive theory to item generation technology.

Full publication and presentation history available in academic CV upon request.