

# Learning Analytics and Deep Learning: New Quantification for STEM Instruction

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## ABSTRACT

Improvements in the quantification of results, the analysis of efficacy, and the inculcation of teaching techniques are now being enabled by advances in emerging technologies. Learning Analytics, Deep Learning, Neural Net Training, and Meta-Disciplinary approaches to the evaluation, selection, and preparation of instructional personnel are now available. Across the millennia, history reports that sages, teachers, and mentors have been sought to help prepare people for productive lives. Past evaluations of those searches have been based on subjective and unquantified impressions. Human emotions have masked any modest ability that previous generations had to evaluate pedagogical effectiveness. This paper adduces data to show how this conflation of the teacher's attractiveness and their effectiveness has predestined early attempts to evaluate teacher skills to disappointment. During research into virtual conversational interfaces, the authors observed a number of issues concerning teacher evaluation. Researchers have made significant strides in Learning Analytics and this suggests that Artificial Intelligence scientists may have insights that could be useful in live-instruction environments. Also, several emerging capabilities in the computational sciences have showed both current utility and future promise. These new technologies are outlined and reviewed. The paper considers emerging capabilities of machine learning and learning analytics. They should provide improved evaluation capabilities of human teachers. All of these issues are then synthesized to produce a viable path to a new set of psycho-metric tools for a better pre-selection evaluation, tailored training, and final competency assessment of STEM instructional personnel. This is an especially pressing current concern of the authors.

## ABOUT THE AUTHORS

**Jennifer H. Nolan, PhD**, is the President of Catholic Polytechnic University and Professor of Psychology in their College of Arts and Sciences. Her earlier work specialized in memory, dementias, stroke and insulin resistance. She is a brain plasticity specialist and certified Cogmed provider. Previously, she was the C.O.O. and co-founder of a stroke and brain injury rehabilitation center. Dr. Nolan has taught university courses at the University of California Irvine, Loyola Marymount University, and Glendale Community College. She has conducted local and nationwide clinical trials, and published in both scientific journals and popular magazines. She received a BA in Psychology from Loyola Marymount University, Los Angeles and a Ph.D. in Psychology from the Dept. of Cognitive Science at the University of California, Irvine.

**Dan M. Davis** is a research staff member at Catholic Polytechnic University and is active as a consultant at the Institute for Creative Technologies, University of Southern California (USC), focusing on large-scale DoD simulations and avatar uses. Prior to retirement, he was the Director of the JESPP project at USC for a decade. As the Assistant Director of Advanced Computing Research at Caltech, he ran Synthetic Forces Express, bringing HPC to DoD simulations. He also served as a Director at the Maui High Performance Computing Center and in computer research roles at the Jet Propulsion Laboratory and Martin Marietta. He was the Chairman of the Coalition of Academic Supercomputing Centers and has taught at the undergraduate and graduate levels. As early as 1971, Dan was writing programs in FORTRAN on one of Seymour Cray's CDC 6500's. While in the Marine Corps, he saw duty in Vietnam as a Cryptologist and retired in 2002 as a Commander, U.S.N. He received B.A. and J.D. degrees from the University of Colorado in Boulder.

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**John J. Tran** is the Chairman of the Computer Science Department of the Catholic Polytechnic University and he is a Major in the California Air National Guard. He has worked at ISI, USC, the Stanford Linear Accelerator Center, Safetopia, and Intel Corporation. At USC, he focused on Object-oriented software engineering, large-scale software system design and implementation, and high performance parallel and scientific computing. Air Force tours included the White House Communications Agency and Kirkuk Regional Air Base (Iraq), where he was the Communications Squadron Commander. He received both his BS and MS Degrees in Computer Science and Engineering from the University of Notre Dame and was awarded his PhD in Computer Sciences at the University of Southern California, where he was an advisee of Dr. Robert F. Lucas.

**Frederica J. Stassi** is a Science Education Analyst, working in the Central Coast of California. Her background includes research for the National Science Foundation in which she was funded to study pedagogies and efficacies in U.S. Science museums. This research involved museums from the East Coast to O'ahu in Hawai'i. Her doctoral research was conducted under the guidance of Professor William McComas and focused on the development of science standards for the State of California. She received a B.A. degree from Tabor college in Hillsboro, Kansas as well as an M.A. Degree in music performance and an Ed.D., both from the University of Southern California in Los Angeles.