Inculcating Metacognition and Critical Thinking: Pedagogical Infrastructures Employing Virtual Humans

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ABSTRACT

This paper reviews the issues of deficiencies in metacognition and critical thinking skills in today's workforce, identifies some current constraints on effectively addressing those issues, and reports on advances in virtual human interfaces that can enhance efforts to address current educational impediments. The authors assert that these approaches would not only be effective at all levels of education, they present their case that instantiating these pedagogical approaches at the earliest point in the educational evolution of the student capabilities would bear the most fruit in operational settings. The paper opens with a view of the need for both metacognition and critical thinking skills in today's environment and a report on the number of leaders, analysts, and staff who decry the current state of those skills. The ability and need to begin this training with the youngest students is advanced. Then, a review of the recognized pedagogical approaches to improving these proficiencies is countered by an explication of the many personal, organizational, and social hurdles to implementing these approaches. The last major section is a description of recent advances in the modeling and simulation community leading to the availability of conversationally facile virtual humans and other computer agent avatars with the capability of counteracting the obstacles currently hampering the training and education required. Some of the obstacles addressed are class sizes, operational schedule overloads, geographic isolations, and personnel proclivities, preferences, and proficiencies of both educator and student. Recent research outcomes are offered as examples of current capabilities and future research efforts are outlined, previewing new tools that will soon be available to the professionals in this discipline. These capabilities are described with sufficient detail to allow the reader to see if these programs might be applicable in their own work, either now or in the years to come.

ABOUT THE AUTHORS

Dan M. Davis 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.

Frederica J. Stassi. Ed.D. 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 Oʻahu in Hawaiʻi. Her doctoral research was conducted with advice 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 Hillsboro, Kansas as well as an M.A. Degree and an Ed.D., both from the University of Southern California in Los Angeles.

Mark C. Davis, Ph.D. is the Chief Technical Officer at Wood Duck Research, Inc, and is semi retired after careers in the US Navy and as a computer design engineer for both IBM and Lenovo. Rising to the level of Distinguished Engineer at Lenovo, he was responsible for the design of laptop computer cross-disciplinary technology, including PC architecture, embedded systems, open source and virtualization. Previous work was with IBM in the areas of software development and architecture involving security, storage and virtualization. Dr. Davis has been granted well over fifty patents that were filed during his service at both companies. He is a graduate of the Duke University NROTC program and was commissioned as an Ensign, attended nuclear power school, and served as a Submarine Officer for twelve years, including one duty tour as a classroom instructor. He left the active duty as a Lieutenant

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