



ACQUISITION INNOVATION
RESEARCH CENTER

Cognitive Assistant for Training Cost Estimators

EXECUTIVE SUMMARY
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PRINCIPAL INVESTIGATOR

Daniel Selva, *Texas A&M University*

CO-PRINCIPAL INVESTIGATOR

Theodora Chaspari, *Texas A&M University Affiliated*

Alejandro Salado, *The University of Arizona*



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**Ms. Jennifer Bowles, SES, Director, Land and Naval Warfare Cost Analysis Division,
Office of the Secretary of Defense (OSD), Cost Assessment and Program Evaluation
(CAPE)**

Mr. Bryan Coots, Operations Research Analyst, OSD CAPE

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EXECUTIVE SUMMARY

The research team has developed a cognitive assistant to support the training of cost estimators in the Department of Defense (DoD). A Cognitive Assistant (CA) is defined here as an Artificial Intelligence (AI) tool, usually with a natural language interface, that augments human intellect in a specific task by retrieving and processing relevant information from multiple information sources and providing it to the user at the right time. It also has the capability to learn and adapt to the user and the problem at hand.

Cost estimation is a complex iterative process consisting of various steps: gathering the required information, selecting an overall strategy and one or more existing models, developing new models if needed (including calibration and validation), performing the estimate, and conducting sensitivity analyses as appropriate. There are challenges for beginner cost estimators in each of those steps, including dealing with incomplete datasets, appropriately assessing the performance of new models, projecting beyond historical ranges of validity, adequately reporting the level of uncertainty around a point estimate, understanding how to use joint cost-schedule distributions, etc. More experienced cost estimators may also struggle to learn the specifics of a new commodity (e.g., the cost drivers, relative orders of magnitude, etc.).

Currently, the training of new cost estimators is done primarily through traditional instruction in live classrooms, and thus it is a time-consuming process. Traditional instruction typically implies reduced opportunities for hands-on learning opportunities, which are known to improve learning. This type of instruction is also not tailored to each individual, so the pace can be too fast for some trainees and too slow for others. The use of CAs can allow for more interactive and tailored instruction for each individual and area, as demonstrated with intelligent tutoring systems in other areas of education (Corbett et al., 1997).

The idea of using AI tools to enhance the learning of trainees is not new and has been studied for decades (Ong & Ramachandran, 2003). However, in the DoD Acquisition context, we are still in the early stages of incorporating advanced AI tools into workflows and, in particular, CAs have not yet been adopted as training tools. Previous attempts to adopt this technology in the workplace failed because of a combination of insufficient performance of the underlying machine learning (ML) models and lack of familiarity of the users with this mode of interaction. With CAs now being ubiquitous in our daily lives and the significant recent advances we have seen in machine learning, the time is now ripe for infusion of this technology in the workplace.

In an Incubate Phase I of this project (\$100k, Sep 2021—Jun 2022), the research team worked with the sponsor and other stakeholders to define the use case for the CA. We decided to focus on a user that is already familiar with cost estimation methods, but wants to learn a new commodity, namely space systems. The tool was to help the user learn the new material in an individualized way. We developed an initial version of the CA based on an existing agent developed by the team called Daphne. This allowed us to make fast progress as some of the software infrastructure was reused. In addition, we demonstrated the ability to do individualized training in the context of selecting questions for the various learning assessments and learning opportunities that best address the user's needs (e.g., reinforcing weaker areas). An initial estimate of the resources that would be needed to develop and maintain such a tool in the DoD was provided.

The project was approved for a Phase II with the goal of further developing the agent and validating it with real users. A previous report described the activities conducted during the first half of the Phase II effort (\$134k, Sep 2022—Sep 2023). In that first year of the Phase II effort, we developed a second version of the agent that leverages Large Language Models (LLMs) to make the system more flexible, extensible, and easier to maintain. In addition, we developed a 3-module online course on Space Systems with slides, example questions, and quizzes and we started thorough testing of the effectiveness of the tool at Texas A&M University (TAMU).

This report documents the second half of the Phase II effort (\$120k, Oct 2023—Jul 2024). During these 8 months, we have refined the software tool, added new instructional materials, and validated the effectiveness of the tool in the lab with 51 student subjects and with 22 real users at the Office of Cost Assessment and Program Evaluation (CAPE) and the Air Force Cost Analysis Agency (AFCAA). Results from the lab experiment showed that students who used the cognitive assistant scored 6 points higher in the test than students without access to the assistant, suggesting that this technology is promising to improve the efficiency and effectiveness of workforce training. This improvement is likely due at least in part to the assistant simply increasing the time the student is interacting with the material. The software tool and accompanying documentation including a transition plan document have been delivered to the sponsor for transition into production.

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