

GIFTS: Situational Learning of MATLAB Using Data Collection and Analysis Modules Based on Upper-Level Engineering Lab Experiments

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Dr. O’Connell is an associate teaching professor in the First-Year Engineering program at Northeastern University. He studied at the University of Massachusetts at Amherst in 2006 then worked in industry as a Mechanical Engineer working on ruggedized submarine optronic systems. He returned to academia in 2011 at Tufts University planning to work towards more advanced R&D but fell for engineering education and educational technologies. His research now focuses on developing engineering technologies and learning environments, specifically makerspaces, to support engineering education at many levels. He’s also heavily involved with his local FIRST Robotics Challenge team as a mentor.

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Introduction

The first-year engineering courses of Northeastern University involve mixed discipline cohorts with a curriculum that reflects the range of engineering design and implementation tools they will need in the following years. MATLAB is included due to its use in several upper-level lab courses across disciplines. The FYE curriculum focuses on introductory programming skills and MATLAB syntax. However, the learning activities, developing geometry calculators and games like Tic-Tac-Toe, do not directly apply to their future use cases in lab settings. Game development differs significantly from the algorithm development and logic skills required to create scripts to assist with a complex, research focused experiments. In response to that disconnect, we developed hardware-enabled data collection MATLAB modules to integrate a situational learning experience[1]. These modules enable students to collect data individually and work with a class-level dataset for their MATLAB education. In addition, the assignments include significant scaffolding but also gaps to fill with their introductory MATLAB knowledge, situating that experience in a more complex but recognizable experimental setting.

Implementation

The initial implementation of the curriculum took place in a Fall 2022 Honors-level first-year engineering course of 26 students. It only utilized the UV Level and Human Reaction Time modules, the introductory 2 of the 4 available. The 3 MATLAB assignments were not 100% new, including some previous content, but each had a large part that used the modules. During these assignments, students collected 1295 data points. Unfortunately, the system does not yet track the number of database queries. During the course wrap-up and while prompted about the modules, students reported enjoying the data collection activities but voiced concern over the difficulty of assignments. Three students also noted this in their course evaluations, expressing a similar sentiment of it being interesting but challenging for their programming experience.

The most significant issue occurred during the final MATLAB assignment. It instructed students to use the data set for the Human Reaction Time, which included data like response times and user demographics, to create a visualization demo based on a research question. It provided several examples, such as comparing response times between right-handed and left-handed users or showing the relationship between demographics and target errors. Approximately 1/3rd of the class contacted the teaching assistants for guidance on what to do, asking what step-by-step instructions to earn full credit. The open-ended aspect became a challenge of having too many options and wanting to be told which option they should select. The next iteration of this curriculum will need to consider this unease with ambiguous, open-ended assignments.

- [1] B. O'Connell, "Work in Progress: Teaching MATLAB through Authentic Data Collection and Analysis Experiences using self-contained, guided experimental setups with a range of disciplinary themes," presented at the ASEE 2022 Annual Conference, Minneapolis, Minnesota, June 27, 2022.