Developmentally Appropriate Numerical Analysis for Engineers?

A lot of the functionality of MATLAB for engineering students is in topics that most first-year and second-year students have yet to experience—i.e. statics, thermodynamics, and linear circuits. It is also typical for lower-division students to be unfamiliar with non-linear phenomena, collaborative assessments, computer programming, and numerical problem solving approaches. In California, some 4-year engineering programs (i.e. UCSB) will not accept transfer students without a programming course in MATLAB. It is with these challenges in mind, that I will share my efforts to create developmentally appropriate, context-rich, numerical modelling activities and assess student computational skills.

I teach a numerical modeling course that primarily serves lower-division engineering, mathematics, and science transfer students. The only prerequisite is a semester of Calculus I. Within this context, the primary challenges I perceive are accommodating a diverse, disparately prepared population and assessing their progress through a progression of interdisciplinary, real-world computational applications.

A project-based, integrated lecture-laboratory approach is used to incorporate the learning objectives and provide students with sufficient opportunities to develop proficiency with numerical analysis. Daily instruction integrates opportunities for one-on-one interviews with formal lecture and collaborative group problem solving. In the laboratory, students can compare and debug problems using different mathematical tools related to problem-solving in their current and upper-division courses. They can also interrogate an instructor or a peer's technique, program structure, visualization, formatting and appropriate use of comments. In addition to problem sets, daily narratives of each individual's learning are graded in their online forum posts. The laboratory component provides students an opportunity to collect unique data that they can mathematically model; while structuring the data collection processes and supporting them when they encounter new phenomena or numerical trends. Most students have had experiences with a 'best-fit' line, but typically have not been responsible for the type, error, or limitations of their fit. The implementation of projects as assessments has provided ample opportunities for students to apply numerical analysis through various programming methods and problem-solving tools. They have choice in the tools they use to collect data and the models they develop. In addition, the project-based approach allows me to adjust pacing and incorporate topics of student interest (i.e. rocketry, robotics, video games).