An Integrating Teaching Model of Aerodynamics III

The recent wave of modern pedagogical practices such as student-centered learning, active learning, problem/project-based learning, flipped classroom are largely focused on undergraduate classes and to a much lesser extent in master's and Doctoral classes. This may be because most of the undergraduate engineering curriculum trains students to perform analysis with complex equations and does not provide enough emphasis on other skills that are now needed and expected in professional life. Therefore, according to Gunasekaran (2017) in this Aerodynamics III curricular unit, five essential elements are incorporated in the new teaching model that can promote long-term learning, decision-making and communication skills.

1. **Applying concepts to the real world:** The homework problems are designed for students to apply the concepts they learned in the classroom to real-world applications of compressible flow.
2. **Discussions and Open-ended Problems:** Master students should be able to solve open-ended problems by making the correct assumptions, rather than having the ability to solve simple procedure-type problems without symbolic manipulation, "plug and chug". Open problems should give students experience in finding something new in the process.
3. **Critical thinking:** Critical thinking is not always limited to solving an equation to get an answer. Critical thinking allows students to better understand the subject matter, which promotes long-term memory. After studying each chapter, the student should ask questions such as "Why is this important?" and "Why do we bother to learn this in the first place?" and "Where is it applied?".
4. **Independent research:** Independent research is the process of learning through experience and learning through reflection. Master's classes must always include independent studies as part of pedagogical practices. Independent study is structured to require the student to take initiative, make decisions, and be accountable for the results.
5. **Technical Communication:** In a master's course, students must be able to communicate their understanding of the subject, their method of applying equations, their critical thinking process, and their independent studies through written, oral, or visual communication. Homework reports are evaluated for quality, clarity, and technicality in their written, visual, and oral presentation.

The learning objectives of the Aerodynamics III Compressible Flow Course are:

1. Train the student to relate each concept learned in class to the outside world/application.
2. Train the student to explain fundamental concepts clearly through written, oral, or visual communication.
3. Encourage the student to integrate the different concepts learned in classes, projects, and homework with the help of independent research.
4. Train the student to solve open-ended problems, making correct assumptions and performing appropriate analysis using tools learned in the classroom.
5. Train the student to perform computer simulations related to course work.

Exams are usually the way to assess students' learning ability and understanding of knowledge. However, exams with known procedural problems do not assess the true learning of students. Instead, it assesses students' ability to read and repeat information, which is the most rudimentary form of learning. To facilitate lifelong learning, the assessment system should require students to reflect, understand, synthesize, criticize, and evaluate the knowledge they have learned in the different aspects of the course.

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1- S. Gunasekaran, Integrated Teaching Model in Graduate Aerospace Classes: A trial with Compressible Flow aerodynamics, 2017 ASEE Annual Conference & Exposition, 2017