Motivating Engineering Students to Learn

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Abstract
Many excellent educational materials and tools have been developed to aid students in learning engineering topics. Although these developments are helpful in providing resources and assessment methods, they have little impact if students are not motivated. The goals of my efforts are to learn, develop, and implement motivational techniques that engage and inspire students so they will work to improve their engineering skill sets.

This "innovation" best fits within the FOEE Symposium's topic areas of:
- Project-Based Learning, and
- Active and Self-Directed Learning.

Learning Outcomes and Objectives

Regarding improving student motivation, the expected outcomes are:

1. *Student mastery of engineering principles will improve*. Motivated students are anticipated to spend more time outside of the classroom reading the materials and practicing the skills required to become better engineers.
2. *Students will become life-long learners who will be better engineers in industry and academia.* Having success at internally-driven learning in college is likely to drive continual skills improvement in later life.

My personal objectives for attending this FOEE Symposium are to:

1. learn the methods others use to improve student learning, especially related to motivation,
2. receive feedback and suggestions on my ideas for motivating engineering students.

Background

A considerable body of literature exists on motivation theory and its application to engineering education; however, I have only recently begun to read through this literature and have yet to apply motivational techniques in a systematic manner.

One particularly intriguing motivation model is the Attention-Relevance-Confidence-Satisfaction (ARCS) model described by Keller (Keller, J.M., 1987, "Development and use of the ARCS model of instructional design," *Journal of Instructional Development*, Vol. 10, No. 3, pp. 2 – 10).

The ARCS model is a *systematic* approach to improving student motivation. To be successful, instructional design should include four components:

1. Attention

A prerequisite for learning is to gain and sustain student attention during the period of instruction. Attention strategies include introducing conflict or incongruity, demonstrating the concreteness of the topics at hand, interjecting humor, and encouraging inquiry and participation.

2. Relevance

Course content and active participation should be made relevant to the student. Relevance strategies include relating to the student's experience, demonstrating the present or future worth of the content, and providing opportunities to meet the emotional needs of the student.

3. Confidence

Developing student confidence can influence a student's persistence and accomplishments. Confidence strategies include providing clearly stated, reasonable learning requirements and expectations, gradually increasing the level of difficulty on assignments, attributing success appropriately, and encouraging independence.

4. Satisfaction

Satisfaction is necessary to provide reinforcement for continued learning. Satisfaction strategies include encouraging the application of new skills and providing unexpected rewards, feedback, and praise.

Implementation of the ARCS motivation strategy involves definition, design, development, and evaluation phases.

Learning Activities, Materials, and Execution

Aspects of the ARCS model have been implemented in my junior- and graduate-level courses on fluid mechanics, gas dynamics, and powder processing. A full ARCS design approach has not yet been attempted. Some current applications include:

1. Attention: Start each lecture with a photo or movie related to the topic to be covered in that lecture. For example, if the lecture is to focus on dimensional analysis, a film clip of Godzilla terrorizing a city is shown. Next, a discussion follows connecting the photo/movie to the material to be covered in lecture.
2. Relevance: "Real world" examples and homework problems are included in most lectures and assignments. These problems tend to focus on everyday experiences rather than case studies. For example, when covering conservation of mass, the in-class question, "Is it better to walk or run in the rain?" is proposed. Students are then directed to better define the problem and are guided through the analysis to arrive at a conclusion.
3. Confidence: This aspect of the ARCS model has not yet been implemented in a systematic way in my courses. Some items under consideration are:
   a. structure course assignments to develop confidence while still achieving learning objectives,
   b. develop and distribute scoring rubrics to clarify what topics are most important, and
   c. ensure that the effort spent on various assignments is weighted appropriately in final grades.

   The objective of these changes is to provide a clear, reasonable path for students to be successful in the course.
4. Satisfaction: Again, this aspect of the ARCS model has not yet been systematically pursued. One consideration is to expand the reward possibilities beyond grades:
   a. course-related competitions with prizes,
   b. course-related projects to be presented at conferences,
   c. "consulting" for senior design or community service projects.

   The hope is that students find greater satisfaction applying their skills effectively outside the classroom.

Feedback to Date, Including Concerns

1. Uniformly positive feedback in written course evaluations on the start-of-lecture photos/ videos (Attention) as well as the more relevant example and homework problems (Relevance).
2. Informal, verbal feedback has been positive for incorporating short, in-class, group activities/responses to posed questions (Attention).
3. Significant lack of confidence for students entering fluid mechanics courses due to perceived difficulty of course material. Need to improve Confidence building activities.
4. Considerable time is spent developing relevant examples and homework problems, especially if case studies are to be used.
5. Difficult to implement the necessary oversight and feedback required for alternate reward activities (Satisfaction) in a course of ~270 students.

Discussion

1. Easiest to implement Attention strategies.
2. Developing Relevance materials requires significant preparation.
3. Confidence activities requires careful planning taking into account assessment methods.
4. Proposed Satisfaction elements may not be feasible in a large lecture course. Still looking for ideas.
5. Not certain how to assess impact of incorporating these motivation strategies.

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