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Teaching Technical Topics With a Human Perspective

As an instructor in physical science and engineering classes, I frequently assess teaching tools and techniques that promote student participation and enthusiasm. I've noticed that students tend to "perk up" when I share technical topics in a way that includes human perspectives. This practice involves personalizing topics by referencing other academic disciplines, such as social sciences and humanities.

These human perspectives are intended to complement the primary learning objectives, which typically involve some combination of natural sciences, engineering, technology, and mathematics. In this article, I share some examples of how coursework development for technical subjects can incorporate human perspectives. This article will follow a "backward design" approach: Desired results, then learning experiences.

Desired Results

Instructors interested in melding human perspectives into STEM classes should first chart out what themes they plan to draw on. My goal is to provide students with an enduring understanding of human factors associated with science and engineering. The following themes serve as foundations for student learning outcomes.

Subject	Humanistic Theme
Physical Science	Understanding that the science of earth better prepares humans to take care of earth and improve the lives of its inhabitants.
Introduction to Engineering	Learning that the first fundamental canon of the engineer's code of ethics is to hold paramount the safety, health, and welfare of the public.

Instructors can then create charts that tie together how each specific humanistic theme connects to a learning objective.

Students' success in achieving learning outcomes is measured by graded learning experiences. Within each learning experience listed below, two discussion questions or examples are provided that blend the learning experience with human factors, as opposed to focusing on the purely technical components of the course.

Physical Science

Discussions

Many instructors include discussion boards or in-class discussion as part of the final grade. While in-class discussions have the advantage of promoting more personal, less researched viewpoints, online discussions may be less intimidating to students, thus encouraging more complete student body participation. Questions instructors can use to elicit more humanistic thinking in physical science classes include:

- What obstacles have prevented humans from faster implementation of clean energy sources?
- Why, and to what benefit, are humans driven to study stars and galaxies other than our own?

In-Class Activities

In-class activities are an excellent platform for encouraging individual thought and group collaboration. Successful group activities typically involve either the sharing of materials or reliance on brainstorming. Instructors can assign a question to be considered by a group, then ask students to submit a written response immediately after completing group work. Students can then participate in a larger class discussion about the question.

- Name five specific examples of how the work of physicists (or chemists) have improved your life.
- Overall, technological advancements improve the standard of living for humans. However, human use of technology can lead to damaging effects for our Earth. Name five technological advancements, the related damaging effects to Earth, and previous or current efforts to minimize, or even stop, the damaging effects.

Testing

Test questions typically require short answers, multiple choice, or matching. I usually avoid open-ended questions.

- Which of the following behaviors would be most damaging to a scientist's career? Answer=Dishonesty, falsifying data to support his or her hypothesis.
- Science, art, and religion need not contradict one another because _____ . Answer = All three operate in different domains of the human experience.

Introduction to Engineering

Student Presentations on Engineering Failures

Failure is one of the most human experiences of all. To prepare for these presentations, each student researches three facets of a single engineering failure: Description, technical cause, and associated human factors. The human factors can stem from many aspects of a failure, including human error, human ethics, impact on people's lives, and human reaction in the form of legislation or engineering standards.

- The crash of Space Shuttle Challenger: Students may explore NASA management, their desire to increase the frequency of space shuttle flights, and how they ignored engineers' concerns about the unusually cold air temperatures expected for the morning of takeoff.
- The failure of St. Francis Concrete Dam: Students may explore how the site selection, design, and construction of the St. Francis Concrete Dam was led by a non-engineer, who had risen to the position of chief engineer for the water department as a result of his success with the Los Angeles Aqueduct. Because all decisions were left to the judgement of a single person who lacked formal engineering education and dam expertise, the St. Francis Dam was built on an inadequate foundation of conglomerate rock that softened when wet.

Student Presentations on Engineering History

To prepare for these presentations, each student researches three facets of a single time frame or civilization: Description, innovations in engineering and technology, and associated human factors. The human factors typically involve societal and government structure, the treatment of people, or quality of life.

- Western Roman Empire (~300 B.C.E. to 400s C.E). The innovations in engineering and technology included the use of concrete, aesthetically pleasing architecture, dams, aqueducts, roads, and bridges. The human factors included central government, slavery, entertainment, and art.
- Technological Revolution (late 1800s to early 1900s). The innovations in engineering and technology included electricity, telegraph and telephone, railroads, large-scale water supply, and sewage systems. The human factors included economic growth, public health improvements, and the growth of engineering colleges.

Team Projects

I emphasize that the overarching goal of team projects is to improve people's lives, as is the goal of most engineering projects. These projects then inherently include a human element.

- Using software included with the course, students design and plan construction for a pedestrian bridge meeting given requirements, including the use of recycled plastic.
- Based on experimentation and analysis of results, students recommend to a farmer the most cost-efficient usage of environmentally safe soil and water chemical treatments.

Conclusion

Students in physical science and Introduction to Engineering classes are more attentive when technical topics are complemented with human perspectives. The process of mixing human factors in with technical topics only requires that instructors keep their goals and learning objectives in mind when planning classes.

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