Incorporating Non-Traditional Teaching Techniques in a Technical Core Course

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Introduction

This paper describes motivating the implementation of non-traditional teaching techniques, such as problem-based and cooperative learning, in a technical core course at the U.S. Air Force Academy (USAFA). All students at USAFA are required to take a certain common "core" of courses. Among these courses is an Engineering Mechanics course covering the fundamentals of Statics and Strength of Materials (EM 200). Many of the approximately 600 students who take the course each semester have neither the desire nor the inclination to pursue a technical major. Therefore, the challenge to the Course Director (CD), who responsibility for course content and oversight during the semester, and to the eleven instructors who teach the course, is to effectively engage both the technically inclined (who might find the course moving too slowly) and those who are nearly overwhelmed every period. Because EM 200 is not intended to be an introductory engineering course for technical majors, but rather a course for developing and enhancing critical thinking and problem solving skills, the pace of the course is deliberately somewhat relaxed. This makes it easier to introduce non-conventional teaching approaches, such as cooperative learning. Each of the 40 lesson-outlines provided to the cadre of instructors by the CD includes a "Pedagogical Thought of the Day (PTOD)" encouraging instructors to use innovative teaching methods in the classroom. Weekly lesson conferences are held to exchange lessons learned which instructors annotate each day as "Pedagogical Results of the Day (PROD)." In these conferences, specific approaches and methods are shared with the group and critiqued. The paper briefly discusses the use of the PTODs and PRODs in
EM 200 during the Fall 1997 semester at the Air Force Academy.

Pedagogical Thought of the Day

"Routine and complacency: the nemeses of the teaching profession."

Teaching is an extremely time-consuming and challenging career choice. Besides grading assignments from previous classes and preparing lecture material for upcoming classes, there are the responsibilities of advising students, conducting research, writing publications, and a myriad of other tasks ranging from everyday administrative issues to obscure and miscellaneous additional duties. Military life and its attendant duties bring with them an additional set of responsibilities. With all these pressures, the classroom can suffer. Only through extraordinary effort on the part of the instructors is this avoided. For the most part, the students at the Academy are quite successful in learning the prescribed materials. However, the short in-class contact time gives scant opportunity to really teach and practice critical thinking skills, problem solving, and to motivate life-

long learning — all of those "institutional objectives" that are suppose to supersede the purely technical course objectives. Instead, however, the routine and complacency of the classroom environment tends to cultivate and reward students who regurgitate temporarily memorized solutions (a sometimes successful mode of operation) and instructors who find this acceptable. The challenge to the educator therefore is to take the extra time and effort to make the classroom a productive environment conducive to attaining those higher institutional objectives. The USAFA refers to these as "educational outcomes." It is these seven outcomes that the core curriculum (to include EM 200) is intended to serve.

1. Officers who possess breadth of integrated, fundamental knowledge in the basic sciences, engineering, the humanities, and social sciences, and depth of knowledge in an area of concentration of their choice.
2. Officers who are intellectually curious.
3. Officers who can communicate effectively.
4. Officers who can frame and resolve ill-defined problems.
5. Officers who can work effectively with others.
6. Officers who are independent learners.
7. Officers who can apply their knowledge and skills to the unique tasks of the military profession.

So how do we provide our students with these skills? Certainly, much of the burden lies on the students. They are the ones who need to do the work. Our job is to motivate ideals such as intellectual curiosity and independent learning. This is a formidable task, especially with so many things competing for our time. It becomes difficult to get beyond the first outcome: preparing and presenting technically accurate lectures that the students find interesting and helpful. To complicate matters, *instructors* often find it difficult to push beyond the first outcome since, after all, they are naturally interested in the subject material and *want* to present the information in all its glory and excruciating detail. Unfortunately, those students for whom the core course is outside their primary area of interest don't take a whole lot away from these lectures.

During the Fall 1997 semester, outcomes 2 through 6 have become a primary focus of EM 200. The CD has encouraged his cadre of instructors to look beyond the subject material and to concentrate on getting their students thinking and learning and being excited about thinking and learning. Being a true educator requires much more than traditional lecturing. As such, the CD has tried to encourage instructors, new and experienced alike, to incorporate non-traditional techniques in the classroom via the weekly discussions, as well as daily "Pedagogical Thoughts of the Day" (PTOD).

The intent of the PTODs and PRODs is to get the instructors to reflect on their routine, to move beyond the first outcome, to consider student learning styles, to incorporate non-traditional teaching techniques in the classroom and, even more than these, to help the instructor become the best educator that he/she can be. Student success is no longer an

explicit objective but, hopefully, student success becomes an implicit by-product of the instructor's efforts.

Topic headings for several "Pedagogical Thoughts of the Day" are listed below.

1. Establishing positive student-student interactions in the classroom.
2. Problem solving methodologies.
3. Critical thinking.
4. Active listening (leaning).
5. Student motivation and student participation.
6. Personality (learning) models, e.g. Myers-Briggs.
7. Cooperative learning (definitions and exercises).
8. Problem-based learning (definitions and exercises).
9. Learning and motivation in the college classroom.
10. Studying and test-taking tips.
11. Course and institutional objectives.
12. Tips on effective lecturing.

In addition, a few PTODs have been attached at the end of this paper. As the reader will note, the PTODs don't contain anything novel or "earth shattering." A couple of sentences which refocus and provide some direction for the instructors certainly suffices. The idea is simply to plant a seed in the back of the mind of the instructor.

Of the eleven instructors teaching EM 200, the composition ranges from three first-time instructors to the Department Head, a veteran of almost 30 years. All but one of the instructors are military. For each of the 40 lessons during the semester, the CD prepares lecture notes and homework solutions. Instructors are under no obligation to use the prepared materials, and typically use this material as a starting point for their individual lecture notes. The PTODs are included with these handouts. The PTODs are typically a one or two page discussion on anything from classroom dynamics, student learning styles, and pedagogical philosophies to specific examples of non-traditional cooperative learning and problem-based learning exercises. *The intent is that the instructors will slowly implement some of the ideas into their everyday routine.*

Instructors meet weekly to discuss what worked, and what didn't. These discussions have probably been the highlight for the semester. The dynamics of the meeting have been tremendous. Everyone participating. Everyone learning. Everyone getting excited about going into the classroom and trying something new.

This semester ideas for the PTODs were obtained primarily from four sources:

1. Felder R.M., Stice J.E., and Brent R., conference notes from the 1997 National Effective Teaching Institute (NETI), June 12-14, Milwaukee, Wisconsin.
2. Wankat P.C. and Oreovicz F.S., Teaching Engineering, McGraw-Hill, 1993.

3. Barbara Gross Davis, Tools for Teaching, Jossey-Bass Publishers, 1993.
4. Johnson D.W., Johnson R.T. and Smith K.A., Cooperative Learning: Increasing College Faculty Instructional Productivity, ASHE-ERIC Higher Education Report #4, 1991.

Pedagogical Result of the Day

In conjunction with the "Pedagogical Thought of the Day", instructors were asked to record a "Pedagogical Result of the Day" immediately after each class. These PRODs became the focus of the weekly pedagogical discussions. It should be noted that the weekly discussions were held at the end of each lesson conference and were optional. Despite the fact that the meetings typically didn't get started until the end of the work day, instructor participation was high. The meetings typically lasted 30-60 minutes.

At the writing of this paper, the semester has not ended and no formal review of the PTOD/PROD process has been conducted, however, informal interviews with instructors have been positive. Moreover, the real benefits of the PRODs are likely to surface long after the semester when instructors have time to reflect on their efforts.

> "I came to believe that the material we are trying to get across is second in importance to teaching students *how* to think. I thought the PTODs were an absolutely awesome idea. With 'how the lesson went' fresh in my mind, I could think how well or poorly I did with regard to the PTOD, and improve for next time."
>
> Captain Marty Bowe, New Instructor.

> "Even old dogs learned new tricks."
>
> LtCol Bob Hastie, Veteran Instructor.

Conclusion

Overcoming the inertia of classroom routine requires time, effort and diligence. Student success (as measured by mastery of the course material) can be achieved through traditional lecturing; however, if we wish to move towards the "higher lever educational outcomes" (curiosity, independent and life-long learning), we must move beyond traditional presentations. At the Academy, EM 200 is an opportune arena to incorporate non-traditional approaches. The amount of course material covered, as part of the core curricula, is purposely reduced, allowing time to try new approaches. In addition, the tepid level of interest in the course material by many of the non-technical students motivates the need for new ideas. As such, within EM 200 at the USAFA, the CD prepares PTODs each lesson to stimulate reflection by the instructors on their classroom dynamics. The PTODs include ways to improve lectures (and share lessons learned), enhance student learning, and incorporate non-traditional teaching techniques into the classroom. Instructors are asked to summarize lessons learned after each class as a PROD. Instructors meet weekly to discuss results.

Pedagogical Thought of the Day

Early on in the semester, you'll play a large role in establishing student-student interactions. There are three possible outcomes [1]:

1. Competitive: I swim, You sink; I sink, You swim

"When students are required to compete with each other for grades, they work against each other to achieve a goal that only one or a few students can attain." [1]

2. Individualistic: We are each in this alone

"When students are required to work individualistically on their own, they work by themselves to accomplish goals for learning unrelated to those of other students." [1]

3. Cooperative: We sink or swim together

"When engaged in cooperative activities, individuals seek outcomes that are beneficial to themselves and to all other members of the group." [1] They maximize their own and each other's learning.

"Cooperative learning is the most important of the three types of learning situations, yet currently it is the least used." [2]

There are many reasons why EM200 is ideal for cooperative learning:

1. We've mastered the material and can concentrated on improving our teaching skills.

2. The course is such that implementing cooperative exercise should not introduce time constraints.

3. Students are already arranged in groups.

4. EM200 is a contract graded course.

5. The main focus of EM200 is to build problem solving (critical thinking) skills and to promote life-long learning. Evidence indicates that this is best achieved through cooperative learning.

I have a large number of text and work books on cooperative learning. The library also has many references on the subject. This is what our CEE department is trying to get us to do - go talk to them (Dr. Barbara Millis). The benefits to us and our students make it worth the effort!

References:

[1] Johnson D.W., Johnson R.T. and Smith K.A. *Cooperative Learning: Increasing College Faculty Instructional Productivity*, The George Washington University, 1991.

[2] Johnson D.W., Johnson R.T. and Holubec EJ. *Cooperation in the Classroom*, Interaction Book Company, 1990.

Pedagogical Result of the Day

Pedagogical Thought of the Day

Information from: Felder R.M., Stice J.E., Brent R., "National Effective Teaching Institute Course Handbook", Milwaukee, Wisconsin, 12-14 June 1997

Informal CL Exercises

- **In-Class Team Activities.** Get class to form teams of 2-4 and choose team recorders. Give teams 30 seconds-5 minutes or more to

  — Recall prior material
  — Answer a question
  — Start a problem solution
  — Work out the next step in a derivation
  — Think of an example or application
  — Figure out why a given result may be wrong
  — Brainstorm a question (goal is quantity, not quality)
  — Generate a question
  — Summarize a lecture

  Collect some or all answers. *This activity works for all class levels and sizes.*

- **Think-Pair-Share.** Students think of answers individually, then form pairs to produce joint answer. (Optional) Pairs may then discuss answers with other pairs.

- **Cooperative Note-Taking Pairs.**[5] Students form pairs to work together during the class period. After a short lecture segment, one partner summarizes his or her notes to the other. The other partner adds information or corrects. The goal is for each person to take something from their partner's notes to improve their own.

- **Guided Reciprocal Peer Questioning.**[6] Students work in groups of three or four and are provided with a set of generic question stems:

How does ... relate to what I've learned before?	What if...?
What conclusions can I draw about ...?	Explain why ...?
What is the difference between ... and ...?	Explain how ...?
What are the strengths and weaknesses of ...?	How are ... and ... similar?
What is the main idea of ...?	What is the meaning of ...?
What is a new example of ...?	How would I use ... to ...?
What is the best ... and why?	How does ... affect ...?
Why is ... important?	

  1. Each student individually prepares two or three thought-provoking questions on the content presented in the lecture or reading. The generic question stems are designed to encourage higher level thinking skills.
  2. The small group comes together for peer-questioning where group members take turns answering the questions they generated individually in a discussion.
  3. Following the small group discussion, the whole class discusses questions that were especially interesting or that did not yield a satisfying answer in the small group discussion. It is primarily during whole group discussion that the instructor has a chance for input, clarifying information about the topic presented in the lecture or in the reading.

Pedagogical Thought of the Day

Information from: Wankat P.C. and Oreovicz F.S., "Teaching Engineering," McGraw-Hill, Inc, 1993 (pg 78).

Problem solving can also be taught with discovery methods of instruction. These approaches include simulation, case study, guided design, and discussion. In all these methods students should work on real, or at least realistic, engineering problems. They should help define the problem and then work at developing a solution.

Student work in groups is particularly conducive to learning problem solving. Being in a group of one's peers can help reduce a student's anxiety if it is clear that on one has all the solutions.

Your goal while working with problem-solving groups or individuals is not to give students what they want. Students want the solution. As a professor you want the students to find a solution essentially on their own and to improve their problem-solving skills in the process. Encourage them to verbalize and refuse to let them quit prematurely.

Pedagogical Result of the Day

Pedagogical Thought of the Day

We are approximately 1/2 way through the semester. This is a great opportunity to reemphasize the "Big Picture:" -- Course objectives, 4 Cornerstones of EM200, Educational Outcomes, A.F. Core Values, and on up.

Remind them why they are taking this course: problem solving and critical thinking are important skills for (1) educated people, (2) AF Officers, etc.

EM200

BIG PICTURE

USAFA EXPERIENCE

(1) Tools to Recognize and Solve Problems
- (a) Fundamental Principles (Newton's Laws)
- (b) Problem Solving Techniques / Math Review
- (c) Visualization Techniques

(2) Analysis
- (a) Problem Set-up (FBD)
- (b) Relevancy
  - How does this apply to real world?
  - Equilibrium, Stress, Strain, Defromation

Critical Thinking :

Recognizing, setting-up, and applying some fundamental principle to solve a problem.

(3) Applications - Practice, Practice, Practice
- (a) Axial Loading
- (b) Trusses
- (c) Beams
- (d) Torsion / Pressure Vessels
- (e) Combined Loading

} Neat Stuff

Understand the World Around You
Analyze Stuff
Design Stuff

Pedagogical Result of the Day

Non-traditional english language lessons. Techniques to teaching English at schools and courses. Alternative approaches to foreign language teaching. Classification of non-traditional lessons for teaching vocabulary. Methodology for such lessons. Practical application of non-traditional lessons.Â By meeting them where they already spend much of their free time, the software connects the students with the course content in a context in which they're already comfortable. This could help increase feelings of competence, interest, and autonomy. Technology-enhanced assessments. Visual techniques are divided into traditional and non-traditional. I will tell about non-traditional drawing techniques and give an example of several of them. The advantage of non-traditional drawing techniques is that they allow the child to quickly achieve the desired result. Unconventional drawing techniques, in my opinion, are easier to use, more close to the game, and allow you to quickly achieve successful results. They include interesting non-standard techniques, instantly attract the attention of children and allow them to feel more free and liberated. Unconventional techniques image...Â Previously, the sheet of paper can be painted in a light tone. Sample drawing topics: "Autumn forest", "Flowers", "Zoo", "Butterflies", "World of Animals". Incorporating Non-Traditional Teaching Techniques in a Technical Core Course. James P. Solti, James M. Greer, Jr. and James L. Greer Department of Engineering Mechanics United States Air Force Academy. Introduction. This paper describes motivating the implementation of non-traditional teaching techniques, such as problem-based and cooperative learning, in a technical core course at the U.S. Air Force Academy (USAFA). All students at USAFA are required to take a certain common â€œcoreâ€ of courses. Among these courses is an Engineering Mechanics course covering the fundamentals of Statics and Stre