Becoming a Better Teacher: Adjusting From the Baseline

Jerry W. Samples,Kip P. Nygren
United States Military Academy

Abstract:

The notion that teachers at the college level are effective based on their disciplinary technical skills is a common one. Teachers develop their entry teaching skills based on desire, needs of the student, and importance placed on teaching by their institutions and their colleagues. Every teacher must have some fundamental teaching skills to be nominally effective, and should improve on these skills to become an accomplished teacher This paper presents a teacher development model that begins with baseline teaching skills, those needed to be effective, and addresses the modifications necessary to move from the baseline to the next level of excellence. Teaching experiments, teacher effectiveness, and variations in the depth of understanding of teaching in general as seen through the eyes of senior and junior faculty will be discussed. Finally, the baseline and the advanced teaching methods will be compared in a common course.

Background:

The art of teaching developed slowly throughout academia until the last 30 years when new innovations found their way into the classroom. Collaborative learning, active learning, student centered learning, team teaching, interdisciplinary teaching, guided learning, problem based learning, and interactive learning strategies became the words that described the way forward. Implementation of these methods is a dramatic paradigm shift, especially in the field of engineering education where lecture is the norm. Introduction of design curricula and the need to develop team skills in engineering education opened the door for utilization of advanced teaching methods.

In many other fields of study, these skills found immediate favor, both with the students and the faculty. The humanities and the social sciences embraced these methods and quickly became advocates of the student/faculty interdependent classroom environment, Engineers, scientists and mathematicians are reluctant to enter the unknown of advanced teaching methods, mostly because they were not taught that way. Lecture is best, is the most efficient, and provides the students with what they need: an attitude tied to engineers the world over. The lecture attitude is being replaced in many schools. It is part of the design revolution and the demands by students to be more involved within their own education. It is our belief that use of the advanced methods requires an in-depth understanding of the fundamentals of teaching: a baseline knowledge if you will,

Teacher Development Model

Our teacher development model, fig. 1, begins with a solid understanding of the technical material, understanding and practice with teaching techniques, and experience with teaching. We designate this as the baseline, the fundamental building block that must be present to be a good teacher. The definition is standards based and will vary depending on the school, the faculty, and the students. Yes, the students will let you know if you are on track or not. They will vote with their feet and with the course critiques. To establish a viable baseline, feedback is critical. We enjoy an environment that believes in teaching, where the preparation of the faculty to teach is taken very seriously. In such an environment, teachers progress rapidly from novices, to accomplished teachers.

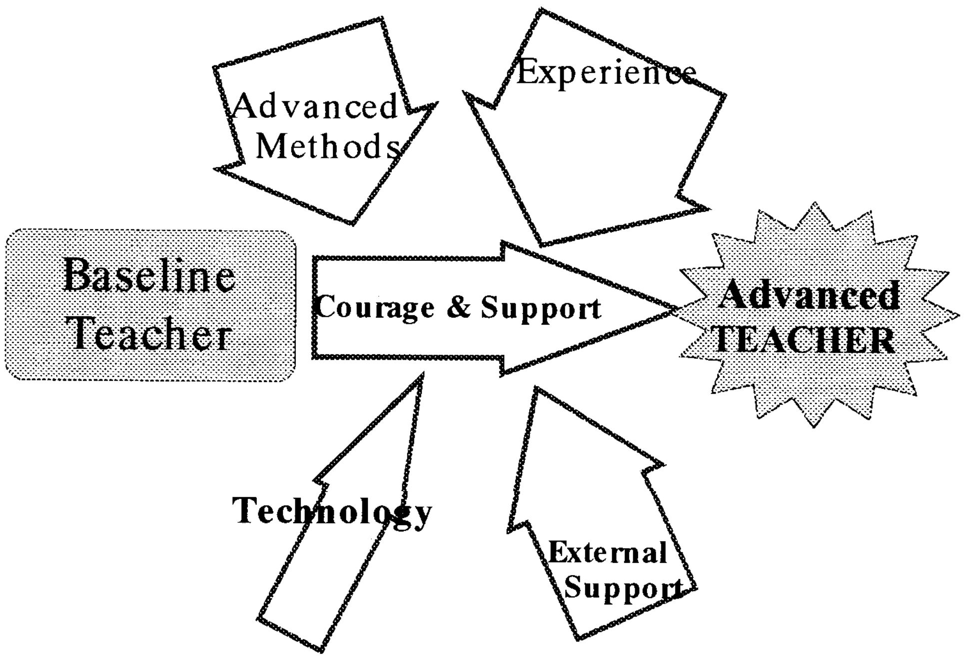

Figure 1. Teacher Development Model.

Our teachers are not lecturers in the classic sense. As a matter of fact, they are excellent facilitators, using a myriad of techniques in the classroom. They use many of the eight lecture methods outlined in Lowman[1] as they take their classes through their paces. Relevance is ensured through introduction of equipment and through laboratory exercises. The normal classroom is interactive and fun. Group discussion is important in the advanced courses and team projects are the norm in the design courses. These require extensive use of non-lecture techniques,

As we move through the curriculum we identify many opportunities to import other teaching methods. Beyond the baseline exist opportunities to grow immensely as teachers. To experiment with these methods requires the ability to move to safer ground, back to the baseline, if necessary. Student performance must be weighed to ensure that the experiment is providing the students what they need rather than satisfying the teachers needs. The teacher must be well grounded in baseline techniques and the advanced methods or failure is certain. As progress is made, training of the teacher is almost as important as training of the students.

What Causes a Teacher to Grow?

A teacher can only grow when they learn advanced methods, or realize that the methods they are using are advanced. Many teachers have moved from standard lectures to collaborative learning and not known it. Many use excellent teaching techniques and are unaware of the fine work they are doing, So, teachers should have some understanding of teaching and learning. Armed with that knowledge, they can expand their horizons and their effectiveness.

The way students learn is an important part of the way we teach. Engineers are knowledge based people, or at least they have been for many years. Introduction of design and the creative elements of engineering meant getting away from knowledge: right and wrong answers became blurred in the creativity that is design, Bloom's hierarchy became an element to facilitate understanding of learning in the cognitive domain, Knowledge, the first step on the hierarchy, was good enough for basic courses. Application, the third step, was often used when solving those single solution homework problems. Synthesis and evaluation, parts of the domain discussed for years, were not put into practice until design was required. Engineers are often divided on the use of synthesis and design in lieu of application and "problem solving". Students need to have the knowledge before they can grow into creative problem solvers. Unfortunately, engineering educators did little to help them grow since we did not advance our own methodology.

The problem is further complicated by the development of the cognitive domain. It is entirely possible that one's development may be limited by their ability to progress through Bloom's Taxonomy. Take for instance the child who in Piaget's model remains at the concrete operational phase. This person can do a lot, as long the situations deal with real objects and events. Abstracts are not easily handled, thus design and it's inherent uncertainty of result will be conceptually difficult.

Similarly, Perry's model starts with dualism, yes and no situations, and proceeds to commitment, absolute understanding and involvement in the material. College students studied seemed to proceed through the cognitive domain at varying rates, many not passing much past the dualism phase. For engineers, this was okay since we were yes-no people. Many of our teachers are that way today, not accepting the uncertainties that is creative thinking. But engineering can no longer rest with absolutes for the creative approach to learning is important. We no longer want a student with A's in every subject except those requiring synthesis. Applications, critical thinking, and creativity are the words that apply to engineering education in the current venue.

As teachers become more aware of the teaching and learning models, they must consider how students learn. Learning theories and learning styles complicate matters for the average teacher, especially when the teacher and the learner use different styles. Further, the classroom is seldom homogeneous when learning styles are considered. Constructivism, dichotomous styles, auditory, kinesthetic, visual, and Kolb's learning cycle are terms that bring fear to many teachers, so much so that they never consider how their students learn.

Enter now the technological revolution that is the classroom of today. Not only are there computers and TV's, there are on-line hook-ups to the entire world. Things happen fast and the average person sees them pass by with great speed. Often, the students are ahead of the professor when technology is considered. An how do we use this technology? That answer usually comes with the concern that time is the most precious commodity when a high technology classroom is being utilized. Who has time to include all that can be included?

An Experiment in Thermodynamics with Baseline and Advanced Teaching Styles:

In the Fall of 1994, an experiment in advanced teaching styles was conducted in the Thermodynamics course at West Point. Two sections of 33 cadets out of a total of 193 cadets enrolled in the course were taught using a team learning method that has been used successfully by Professor Larry Michelson in management courses at the University of Oklahoma. One of the other instructors in the course with long teaching experience was also investigating the effectiveness of a discovery/design technique to motivate learning in thermodynamics and the experiment also captured the effects of this teaching style on student performance. The remaining two instructors were relatively new teachers with two years of experience teaching at West Point, This arrangement afforded the opportunity to obtain some data on the possible effects of different teaching styles in an engineering science course. A comparison of the teachers and cadet sections in the course is shown below.

- Section 1- Army Captain Female — 65 cadets in four different hours
  33 years old — 2 yrs Teaching - 2nd yr Thermo
  MS Degree — Baseline Teacher
- Section 2- USAF Captain Male — 63 cadets in four different hours
  29 years old — 2 yrs Teaching -2nd yr Thermo
  MS Degree — Baseline Teacher

. Section 3- Army Colonel Male 32 cadets in two different hours
47 years old 10 yrs Teaching - 1st yr Thermo
PhD Degree Active Learning Teacher

- • Section **4- Army Colonel Male 33 cadets in two different hours**
47 years old 10 yrs Teaching - 8th yr Thermo
PhD Degree Discovery/Design Methods

The Baseline method taught at West Point involves a thoroughly prepared lecture that will be presented in a highly interactive manner to ensure that the small section of 15 to 18 cadets is engaged in the class. All of the course material assigned for the lesson is presented by the instructor during the progress of the class, and examples are worked by the instructor at the blackboard with the active participation of the students. At the end of the class period, the cadets will have a good set of notes on the day's material and will have seen at least one application problem presented,

The fundamental notion of an active learning strategy is to oblige the student to make the learning effort, not the teacher. The emphasis is on learning, not teaching. The teacher in an active learning setting becomes a crafter of learning activities, and the student learns by full participation in these activities, Additionally, in cooperative or team learning, the student is not alone in these activities. We learn best what we teach, and as a member of a learning team, the students will be helping to teach each other. If the students are prepared for class, then class time can be spent in the expansion and application of the concepts studied in the textbook or reference material prior to class. The objectives of the team learning experiment were:

- Adapt Team Learning techniques to thermodynamics,
- Obtain quantitative data on the results of common evaluations
- Obtain qualitative judgments of students & teacher.
- Assess Advantages& Disadvantages of using Team Learning.

The team learning techniques employed by the instructor included the following

1, Learning Teams. Prior to the first class, teams were selected based on Grade Point Average (GPA) to attempt to equalize the abilities of each team. Since the students consisted of a mix of engineering majors and non-majors, the number of engineering majors on each team was also balanced. The result was a total often teams consisting of three to four students each.

2. Mini-tests. A mini- test was administered to both individual students and teams on a weekly basis. First a five minute quiz was administered to individuals and then the students retook the quiz as a team. The actual student grade on the mini-test was an equally weighted average of the individual quiz and the team quiz, The purpose of the mini-test was not limited team building. It was also to motivate lesson preparation prior to class, since it was administered at the start of class and covered the material assigned for that day.

3. Group Problem Solving. The class was organized to provide most of the class period for applications of the concepts presented in the lesson for that day. This normally consisted of group problem solving and was accomplished by working at the blackboard. Four applications laboratories are an integral part of the thermodynamics course and were well suited for group work.

4. Coverage of the Lesson Material. A basic premise of the team learning technique is that the student has studied all the material and, therefore, it is not productive for the instructor to spend further class time formally presenting the material. Instead, the teacher responds to student questions concerning their study of the concepts and guides the learning activities that apply or expand the concepts.

The discovery/design technique empowers the student to discover the inter-relation of the physical sciences with the engineering science they encounter. Every new concept requires critical thinking, creativity, and practice to ensure that learning has occurred. Students investigate the reason things happen, ask questions, or are guided by questions posed by the teacher. Questions are answered by more questions. Discovery becomes fun, creativity is never discouraged, and learning is physically based. It is important for the students to have open minds and be ready to explore the ''unknown". Finally, problem solving skills are developed that apply in analysis and in discovery. There are answers: good ones and better ones. Students learn to decompose the material and "see" its importance in a grander scheme.

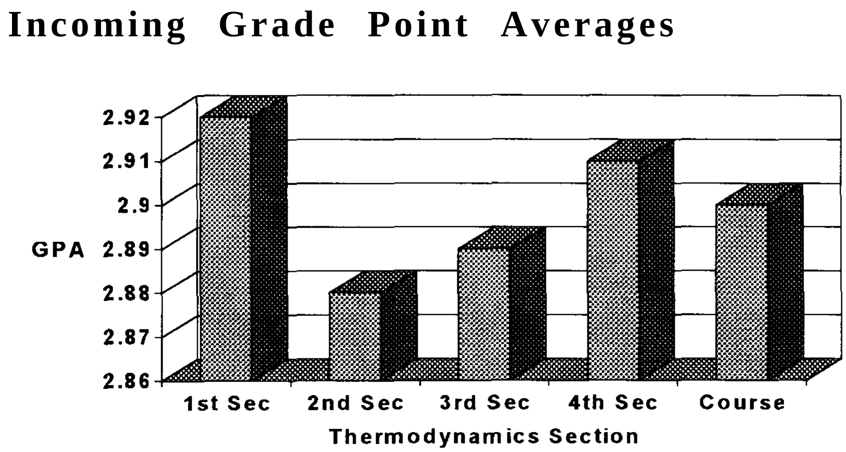

Figure 2. Incoming Grade Point Averages.

Results and Discussion:

1. Incoming Grade Point Average (GPA). As shown in figure 2, the grade point averages of all four sections of thermodynamics were approximately the same. All teachers had a similar population of cadets in their sections.

2. Mini-test Individual and Group Results. The results of the group and individual mini-tests are shown in figure 3. As predicted by Michelson, 90% of the groups beat the individuals in the group. Only one group had one member outperform the group on the mini-tests, and that

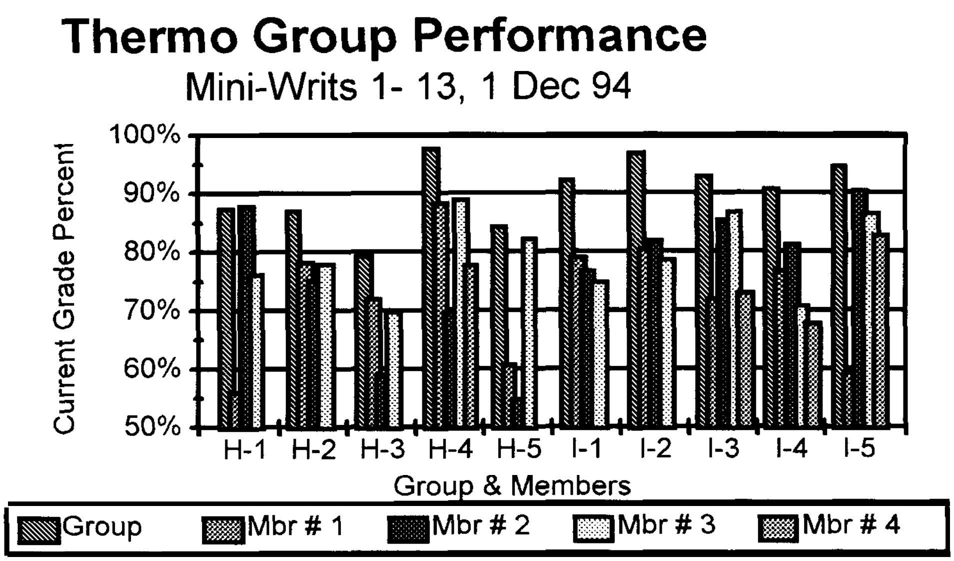

Figure 3. Results of Individual and Group Mini-tests.

, was by only O. 5%. The mini-test results were recorded on the results sheet and available for all in the group to see. In addition, the mini-test results were posted in the classroom. Each of the learning teams maintained a folder in which to keep their test result.

3. Common Exam Performance. For the first examination, figure 4 demonstrates that something was occurring in the active learning sections. The average for the active learning sections was a statistically significant 11 percentage points below the average of the other cadets in Thermodynamics. The active learning technique was new to all the students and, therefore, it might be expected that they would not perform well on the first examination.

4. The results of the second common examination showed a very strong improvement in the active learning section and a slight drop in the performance of the other students. The difference of about two percent in averages was not statistically significant.

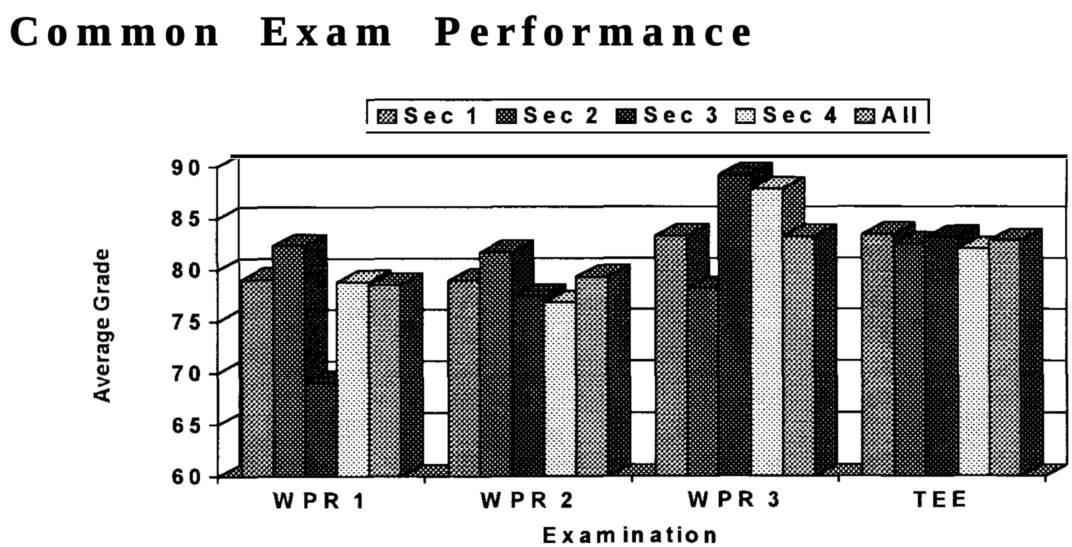

Figure 4. Performance on Common Examinations

The third examination saw the cadets in the active learning section and the discovery/design section score significantly beyond the other two sections. These techniques appeared to make a difference in cadet understanding of thermodynamics.

5. USMA Course Critique Results. The course and academy wide course end surveys showed the cadet in the active learning and the discovery/design sections (sections 3 and 4) to give higher ratings to the instructor and the course, as shown in figure 5. The ratings are based on a scale of O to 4.0 with a higher numerical rating equating to better satisfaction. Significant questions on the survey are listed in table 1.

Thermo Course Critique Results

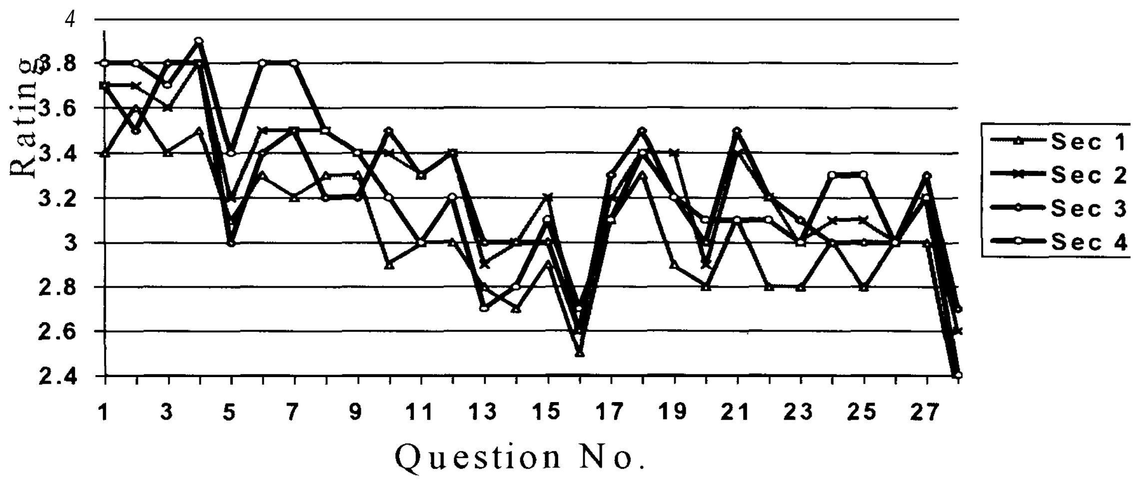

Figure 5. Course Critique Results.

1. My Instructor Communicates Effectively
2. My Instructor was enthusiastic and energetic when presenting course material
3, My Instructor encouraged students to be responsible for their own learning
4. My Instructor had a structure or plan for every lessons learning activities
6. My Instructor was concerned with my learning
7. My Instructor stimulated my thinking
8. My Instructor showed my ways in which the course was applicable to my future
9. My Instructor helped motivate me and gain max. benefit from the course
14. The assignments could be completed within the guideline of 2 hr.
20. Compared to other courses at West Point this course was more demanding
21. My mastery of the subject material has increased because of this course
22. My ability to think critically has increased because of this course
23. My motivation to learn and to continue to learn has increased due to this course
25. This course got as much or more of my efforts as other courses this semester
27. Whether I liked it or not, I found this course academically rigorous

Table 1. Sample Course Survey Questions

Conclusions:

1. Students initially had difficulty adjusting to the active/team learning technique. This was a different method of learning for all of them and it showed on the first examination. Student performance improved during the semester. Whether this was due to becoming comfortable with my teaching methods or due to the fact they knew they had to study after the first exam is unknown.

2. Overall, student performance in thermodynamics was approximately the same for all four sections in the course as measured by the Term End Examination. The course wide survey indicates greater satisfaction with the advanced teaching techniques employed in sections three and four.

3. The students learned the lesson material without the instructor covering all the lesson content in class. This is important to understand when you have many sections of a course that are all giving the same examinations. No teacher wants their students to be at a disadvantage in common examinations and this compels one to concentrate on ensuring that the students are familiar with all the content because the other instructors are covering it. The results of this study do not support that conclusion.

4. This experience with active/team learning points to the following advantages of these active learning techniques.
   - Students were responsible to study prior to class.
   - More time can be spent on applications and problem solving.
   - The teacher has more flexibility to respond directly to student problems with the material.
   - The student is not alone in the course.
   - These techniques promote teamwork.
   - The class is more interesting for both the students and the teacher.

5. Active/team also has the following effects, which may or may not be beneficial.
   - Students are not used to being responsible and require some transition time.
   - Significant effort is required for mini-writ preparation and grading.
   - The teacher has less control of the flow of the class.
   - Lack of control can be a problem for inexperienced teachers.
   - The students do not obtain a complete set of notes from the blackboard, since the instructor does not cover the material with notes on the board.

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COLONEL JERRY SAMPLES received his BS in Chemical Engineering from Clarkson College of Technology in 1969, and entered the Army as a Corps of Engineers Officer in 1970. He received his MS and PhD in Mechanical Engineering from Oklahoma State University in 1979 and '83 respectively. He is a Registered Professional Engineer in Virginia and serves as the head of the mechanical engineering program at West Point.

COLONEL KIP NYGREN is Professor and Head of the Department of Civil & Mechanical Engineering at the U.S. Military Academy, West Point, NY. A 1969 graduate of the Military Academy, he earned MS degrees from Stanford University and a Ph.D. from Georgia Tech in Aerospace Engineering. He is enthusiastically committed to improving engineering education.