Master Teacher Program
2007 Project Anthology

Center for Teaching Excellence

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MAJ Chad Schools

SOCSCI
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Master Teacher Program Project Guidelines

Classroom Research Project

The capstone experience of the USMA Master Teacher Program is a Classroom Research Project and paper. According to Pat Cross, Classroom Research is "the careful, systematic, and patient study of students in the process of learning, and more specifically of how students are responding to our efforts to teach them. The task for Classroom Research is not so much to study learning in general, as to study learning in particular as it takes place -- or fails to -- for your students, in your classroom, and in your subject matter, with your particular teaching skills and preferences."

The characteristics of Classroom Research define it – at its core, it is learner-centered, teacher-directed, and context-specific. You're going to assess an issue that matters to the learning of your students, based on what you see in your classroom and your course.

The process:

(1) Pick a focus. Think about your classroom – how do you interact with cadets, what classroom activities predominate, why did you choose them, through what activities does learning occur, and where could you use a little improvement? Brainstorm the issues that you tend to think about. What activity(s) would you like to focus on for classroom research?

(2) Survey the literature to see what other teachers have done with that topic. What strategies have they used; what conclusions have they drawn? You will better formulate your own plan, and possibly branch into a new area you've just discovered as a result of your literature search.

(3) Develop a plan. How can you look at the issue? Can you try a new strategy with each new unit, and then compare at the end of the semester? Maybe develop five or six small group activities, conduct one per lesson, and then assess them at the end of two weeks? How will you assess the outcomes? There are obvious indicators – grades on projects, homework, and exams. You can look at student participation and interaction, tracking how often and how well your students speak up. You can ask your department peers to observe a few classes and provide feedback about how they think your new technique worked. You can – and should – also ask your students, using surveys or minute papers. After you've tried something new, ask them to assess what they liked and didn't like about it. Refer to Angelo and Cross (1993) for more classroom assessment techniques.

(4) Analyze your information. You've gathered grades, surveyed your students, and made notes after every class. What does all of the information add up to? You might use statistical techniques, but you might also look at the information in a holistic and qualitative manner – what patterns do you see?

(5) Report the information. Write it up for your MTP project, and potentially to submit it to a journal or academic conference.

Literature Review Project

Participants also have the option of conducting and writing a literature review addressing a teaching and learning topic, in lieu of the research project. Literature reviews should focus on a specific topic area within teaching and learning, and may potentially be submitted for inclusion in the POD/NTLF TEACHING & LEARNING ONLINE RESOURCE CENTER. To that extent, literature reviews should follow a specific format, and topics should be approved by Dr. Evans.

The POD/NTLF Format:

- Topic, Author Information
- Topic Overview -- 500-1,500 words short essay describing key issues, history of practice, practice variations, beneficial attributes, controversial aspects

- An annotated bibliography of the most influential, current, and useful resources, 50-150 words per resource (no more than 10-12 items)
- Additional Resources --- Citations of additional print, web, or video resources, without annotation.

Sample literature reviews, a writing template, and a list of suggested topics, are available on Blackboard.

Resources

Useful texts:
Angelo, T.A., & Cross, P.K. (1993). Classroom assessment techniques: A handbook for college teachers, 2nd ed. San Francisco: Jossey-Bass.

Cross, K.P & Steadman, M.H. (1996). Classroom research: Implementing the scholarship of teaching. San Francisco: Jossey-Bass.

Useful websites:
http://www.dean.usma.edu/centers/cte/
http://www.evergreen.edu/washcenter/resources/acl/c1.html
http://www.accessexcellence.org/LC/TL/AR/
http://www.prodait.org/research/index.php

Keyword List – use to stimulate ideas on what you might investigate for your classroom research.

Active Learning	Classroom Participation	Cooperative Learning	Case Studies
Discovery Learning	Experiential Learning	Problem-Based Learning	Questioning Techniques
Student Presentations	Advising	Assessment of Learning	Methods
Cheating	Grading	Testing Formats	Assessment of Teaching
Classroom Observations	Lesson Planning	Teaching Portfolios	Course Development
Course Goals and Objectives	Student Course Evaluations	Distance Education	Computer Assisted Instruction
Cognitive Mapping	Intellectual Development	Problem Solving Skills	Ethics in Teaching
Evaluation of Teaching	Student Evaluations	Peer Reviews	Teaching Portfolios
Humor in Teaching	Interdisciplinary Teaching	Team Teaching	Instructional Technology
First Class Meeting	Electronic Media	Films and Videotapes	Laboratory Instruction
Mentoring Junior Faculty Members	Writing Across the Curriculum	Psychological Foundations of Teaching and Learning	Student Motivation
Learning Styles	Teaching Styles	Student Epistemology	Teacher Epistemology
Teaching Strategies	Lecturing	Debates	Demonstrations
Discussions	Games and Role Playing	Independent Study	Seminars
Simulations	Student Projects	Study Groups	Studio Instruction
Tutoring	Written Assignments	Philosophies of Teaching	Texts and Readings
Course Packs	Handouts	Individual Consultations	Group Consultations
Evaluation of Teaching	Student Evaluations	Peer Reviews	Teaching Portfolios
Classroom Observations	Learning Styles	Podcasting	Blogs
Critical Thinking			

ABSTRACTS

C&LS

MAJ Matthew Armstrong
Title: *Interdisciplinary Learning for Chemical Engineering Students from Organic Chemistry Synthesis Lab to Reactor Design to Separation*
Authors: Matt Armstrong, Richard L. Comitz, Andrew Biaglow, Russ Lachance, Joseph Sloop
Abstract: A novel approach to the Chemical Engineering curriculum sequence of electives here at West Point enabled our students to experience a much more realistic design process, which more closely replicated a real world scenario. Students conduct the synthesis in the organic chemistry lab, then conduct computer modeling of the reaction with ChemCad and Mathematica, analyze chemical separation processes, and design a reactor system. This interdisciplinary learning approach demonstrated to students that all of their courses are meant to compliment each other, their learning, and experiences.

MAJ Timothy M. Hill
Title: Classroom Participation (Literature Review)
Author: MAJ Timothy M. Hill
Introduction: Volumes of literature have been written regarding the value and importance of student participation in classroom discussion. Few, if any, instructors (particularly at the college level) would dispute the position that students who participate in class learn more. This is, after all, how most of us feel we learn the best. However, actual evidence to support this hypothesis seems somewhat lacking. Rather, for most educators, it is almost intuitive that creating an environment where students freely converse and share ideas cannot help but foster a better understanding of course material and an appreciation for what it means to be a mature learner and thinker. But educators must be cautious in their assertions. Today's teachers must be aware of the ever-changing nature of the classroom and the wide diversity of learners. We must continuously re-evaluate what we know to be the "truth" about education.

COL Leon Robert
Title: *Class attendance: Mandatory or optional?* (Literature Review)
Author: COL Leon Robert
Introduction: Class attendance in undergraduate courses is a frequent topic of discussion among students, professors, and administrators. Although this diverse group at any university would probably never agree on any present or proposed attendance policy, they probably would agree that class attendance is far from perfect. Class attendance (or absenteeism) is a major concern for educators at many institutions of higher learning (Devadoss and Foltz 1996). College students enjoy many academic freedoms, including the decision whether to attend specific classes on any given day since attendance in college is not mandated by law. If academic success correlates with high rates of classroom attendance, then why do some college students choose to skip class?

C&ME

MAJ Tony Jones
Title: *Teaching Mechanical Engineering to the Highly Uninspired*
Authors: MAJ Tony Jones and LTC Grant Crawford
Abstract: It is widely accepted that undergraduates require a general education in numerous disciplines as part of being a well rounded, educated citizen. Courses in arts, humanities, foreign languages and many other disciplines populate the student schedule. At the United States Military Academy (USMA) at West Point, all non-engineering majors are required to complete a three course engineering sequence as part of their undergraduate degree program. This sequence typically begins in the fall of their junior year and can be conducted in one of seven engineering disciplines. Predictably, the students taking these sequences

have tended to view this experience more as a distraction from their academic program rather than an enhancement to it.

In response to student and faculty dissatisfaction with the final course in the mechanical engineering sequence in 2004, the lead author of this paper undertook a major revision of the course prior to the fall of 2005. The primary question posed: How do I motivate a student who does not want to be here in the first place? As part of the revision process, he examined techniques that could be used to promote a team environment in the classroom. Demonstrating the relevance of the course material and increasing student involvement were also areas of focus.

These goals were achieved by implementing a program of short term goal setting and hands-on projects that supported the overall objectives of increased student learning and achievement of USMA's Engineering and Technology Goal outcomes. The results were remarkable. Students, who expressed concern about their abilities to perform well in the sequence at the beginning of the second course, completed the program wondering if they had made a mistake in NOT majoring in mechanical engineering.

This paper describes the issues, examination of methods used in other courses to enhance student motivation, implementation of techniques in the second and third courses of the sequence, assessment of the results, and recommendations for its applicability outside of USMA. Student feedback and the comparative results of student surveys from previous iterations of the course as well as current student surveys are presented. The students discuss their own motivations and reactions to the course. From the teachers' perspective, we discuss what worked well and what items could be improved or deleted. Finally, we will make the case that engineering should be an integral part of every student's undergraduate experience due to such factors as an increasingly technologically based society and the lag in engineering education in the United States as compared to the rest of the world.

MAJ Seth Norberg
Title: *Commercial Breaks in the Classroom*
Author: *MAJ Seth Norberg*
Introduction: After teaching a required undergraduate thermal-fluids systems course to a broad assortment of engineering students, many of whom saw no point in their enrollment in the course, I attempted various methods to spur their interest, keep their attention, and liven the discussion. The tipping point was during my second semester when I taught a majority of students (90%) who would not take the follow on course or subsequent courses in mechanical engineering. I saw the value in developing a rapport with the students and also answering the "so what" question that the challenging student so often poses. In short, I saw the necessity of the commercial break in the class room.

Research shows that the college age student initially has a 15-20 minute attention span which becomes shorter as the lecture progresses. Further research showed that students recalled 70% of the information presented in the first 10 minutes of class and only 20% from the last ten minutes

Changes in the environment recruit attention. The ability of changes to capture attention can work to the advantage of the lecturer. Variation in pitch, intensity, and pace of the lecture, and visual cues such as gestures, facial expression, movement to the blackboard, the use of demonstrations or audiovisual aids—all of these recruit and maintain attention to the lecture.—McKeachie.

Expanding on McKeachie's statement and focusing on changing the environment, I realized that many of the demonstrations, slide shows, movies, and stories could be pre-planned to coincide with lulls in the lecture. From experiences from teaching the course two previous semesters, the "commercial breaks"

consisted of demonstrations, slide shows on the topic, an engineering story, a military story, or a personal story programmed at the half way point of the 55 minute lecture.

The demonstrations ranged from a cold can of soda (showing closed vs. open system) to a Brodhead-Garret air conditioning device. Slide shows included PowerPoint slides of photos of different types of pressure measuring devices, pipes, devices within a power plant. Engineering stories consisted of my limited experiences, or background history of how an experiment was conducted. Military stories attempted to show the concepts from class in military technologies as well as soldier initiatives—using evaporative cooling to cool water bottles in the desert. Personal stories included, "so there I was driving through the middle of Texas in July and my engine temperature gage was moving up fast—What did I do?" as well as the occasional topic of the day, "why are you so tired today?" and the response of "there was a surprise inspection at 0400 this morning."

DFL

MAJ Daniel Dorado
Title: *Periodic Quizzes and Student Response Research in LA203, Basic Standard Arabic*
Authors: *MAJ Daniel Dorado & LTC Gregory Ebner*
Introduction: During the course of LA203-204 (Basic Standard Arabic), we noticed a definite lack of cadet attention to the assigned homework. Most cadets did not complete the assigned exercises within the textbook in preparation for each day's lessons. From that observation, we began to realize that cadets were not committed to regular completion of out of class assignments. Within the foreign language instruction community, immersion is recognized as one of the most effective methods of learning a new language. Placing a student in a constant or near-constant environment in which the foreign language is the focus of conversation and comprehension has demonstrated benefits to the student's learning. Homework from a foreign language class, though imperfect, is a form of immersion. It provides the student the opportunity to work within the immersive environment left behind in the classroom. While homework assignments are often regarded as a useful learning tool in most disciplines, because of the immersion factor, they are especially important in beginning language courses. Homework assignments at the basic level of language often reinforce concepts that form the foundation of the language. Students with a strong foundation in these concepts will be able to continue with confidence in higher level language courses. If cadets were not completing their homework assignments, then they were missing out on this opportunity for learning, and essentially failing to build a strong foundation to set the stage for future success in the language.

Our goal was to devise a change in the course of instruction that would encourage cadets to spend more time on homework in preparation for each class meeting. To accomplish our goal, we did three things. First, we redesigned the quizzes to more closely resemble the homework assignment for a particular lesson and increased the number of quizzes. Second, we measured the amount of time cadets spent in preparation for class both before and after the change in the course syllabus. Finally, we determined if the frequency of homework-based quizzes achieved the goal of increased devotion of time to homework preparation.

LTC Gregory Ebner
**Collaborated – see joint entry under MAJ Daniel Dorado*

DMI

COL Peter Curry
Title: *Changes to the Department of Military Instruction Core Military Science Program and Learning Model*
Authors: COL Peter Curry, supported by CPT Daphne Austin, MAJ Michelle Goyette, MAJ Bryan LeClerc, MAJ Francisco Leifa, MAJ Javier Martin Gil, MAJ Christopher McKinney, MAJ John Nawoichyk
Overview: This memorandum outlines the proposed changes to the Department of Military Instruction's Military Science Core program. Currently, Cadets attend Military Science core courses 20 lessons per semester in both semesters, and receive .5 credit hour per semester. The proposed changes consist of three main areas: establishing a 40 hour core course that Cadets attend one semester per year, offering each course both semesters, and increasing MS credit to 1.5 credit hours per course. These changes will be implemented in AYT08-01 to meet Basic Officer Leader Course (BOLC) Common Core Task requirements and current Superintendent and Commandant guidance.

The Military Science curriculum serves as a critical component of the Military Program at the United States Military Academy by providing Cadets the knowledge and skills necessary for continued Cadet development and success as Army officers. Military Science is the study of the Profession of Arms during the academic year as a continuum of the Cadet Summer Training programs. Military Science instruction provides basic competence in foundational military skills and troop leading procedures so Cadets can more efficiently exercise leadership roles during Cadet Summer Training thus helping to develop an understanding of their role as future leaders in the Army. The entire Military Science curriculum is built upon specific instructional goals and performance objectives outlined in this proposal.

CPT Daphne Austin, MAJ Michelle Goyette, MAJ Bryan LeClerc, MAJ Francisco Leija, MAJ Javier Martin Gil, MAJ Christopher McKinney, MAJ John Nawoichyk
**Collaborated – see joint entry under COL Peter Curry*

LTC (R) Richard Metro
Title: *Large Classroom Instruction - Teaching Tips and Techniques* (Literature Review)
Author: LTC (R) Richard Metro
Introduction: The purpose of this paper is to briefly explain the reason that we have so many large classroom courses in universities today, while most teachers and students prefer small classrooms. Then the drawbacks to students and teachers in these large classrooms will be briefly explored. The majority of the paper will focus on techniques and procedures that can be employed to minimize the negative aspects of large classrooms.

EE&CS

MAJ Duane Fairfax
Title: *A Deliberate Integration of Information Technology in the Classroom*
Authors: MAJ Duane Fairfax, Kevin L. Huggins, COL Bryan Goda
Abstract: The Information Age has revolutionized the way students learn in the classroom. The United States Military Academy (USMA) emphasizes the importance of Information Technology (IT) through an academy-wide IT specific goal. This goal supports the USMA's mission of producing Army Officers who can respond effectively to technological changes in the defense of our nation.

Courses augmented with IT can be daunting for cadets who lack the experience and confidence level to succeed in the course. As a result, these types of courses are avoided by cadets if at all possible. This is

not an option for an aspiring officer who will lead the soldiers of tomorrow on a digitized battlefield. Since 1990, cadets have been issued a computer which has played a central role in bringing the power of IT to all graduates of the Military Academy. Integration of IT in the curriculum begins early with every cadet receiving a laptop computer. An integrated software package is included to support any course of instruction. Cadets receive two courses in IT, one in their freshman year and one in their junior year. The freshman course teaches the cadet the basic functionality of the laptop, a basic programming language, and creating a basic website. The junior course builds on the freshman course by teaching the cadets to create an advanced website, design and build a network, manage a database, and create an information system.

IT plays a central role in several overlap courses between engineering and the humanities in such areas as information warfare, terrorism, and the legal aspects of intellectual property rights. What makes this approach unique is the methodical diffusion of IT into course design which removes the barrier between learning and the implementation of IT as an academic multiplier. An academy-wide committee consisting of 12 members is responsible for examining collected data to see how well the Military Academy is meeting its IT goal. This data comes from a variety of sources such as end of course surveys, graduate surveys, commander's surveys and interviews, advisory boards, recent graduate seminars, and rotating faculty. The data helps to assess both IT outcomes and objectives. The proposed approach empowers cadets to embrace technology and leverage its benefits and not classify it as a learning impediment. Ultimately, this concept will allow cadets to design, implement, and maintain critical information systems utilized in the Army.

MAJ Jeffrey Gribschaw
Title: *Active-HDL, Multisim, Cadence … There has got to be a better way to teach CAD/E tools.*
Authors: MAJ Jeff Gribschaw, MAJ Paul Patterson, COL Bryan Goda
Abstract: Numerous computer aided design (CAD) and engineering (CAE) software products exist to automate the design process, but how does an instructor efficiently incorporate those tools into the classroom to facilitate learning? A typical electrical engineering major at this school may use up to twenty different software products over the course of two and a half years. CAD/E tools play an important role in enabling students to take concepts learned in the classroom and apply them to real world problems and significantly enhances student learning. Many text books come with support for a specific CAD/E tool with many examples, but gloss over the use of the CAD/E application and expect that the student already knows the software or will learn it on their own. Many courses do the same, based on the amount of material they are required to cover, and there is not enough time to also instruct students on the operation of a specific CAD/E tool. In our digital logic and computer architecture courses, we currently spend approximately two hours over two semesters teaching students to use Active-HDL; we require students to use the program in multiple labs and homework assignments to reinforce key concepts in Very High Speed Integrated Circuit Hardware Description Language (VHDL). Due to the fact that our instruction only touches the surface of the program's capabilities, students expend a significant amount of additional time and effort learning to use Active-HDL at the expense of learning the key concepts we would like to emphasize with VHDL. Too often the students spend countless hours attempting to learn the software and fail to grasp the actual concepts that the software was supposed to reinforce. One course of action to eliminate this problem is to stream line the software tools used throughout the curriculum. This would require a conscious, program-wide effort to redesign the course curriculum using only one CAD/E product and is not a feasible solution to our problem. Instead, we propose a coordinated software effort within a program and an assessment program geared specifically towards the CAD/E tools used in each course to help instructors enhance classroom instruction and out-of-class independent student learning of new CAD/E Software. This paper will focus on the software application Active-HDL, the programming language VHDL, and an assessment tool we use to improve student proficiency with these CAD/E tools.

LTC Kevin Huggins
**Collaborated – see joint entry under MAJ Duane Fairfax*

MAJ Paul Patterson
**Collaborated – see joint entry under MAJ Jeffrey Gribschaw*

MAJ Paul Stanton
Title: *Cooperative learning in a college classroom: a survey emphasizing individual accountability* (Literature Review)
Author: MAJ Paul Stanton
Introduction: Over 600 studies in the past 90 years have been dedicated to validating the assertion that students learn better when working together in small groups (ERIC, 1992). Whether referred to as collaborative learning, cooperative learning, or simply group work; the results of the research are consistent: students retain information longer, students perform better during evaluations, and students appear more satisfied with the course material (Davis, 1993). Superficially these results would strongly suggest adopting cooperative learning in the classroom, but they do not indicate the amount of detailed thought, preparation, and maintenance required for students to successfully learn in such an environment. Establishing the appropriate conditions for learning in a group setting is a critical component for success.

One of these conditions requires teachers to ensure that individual members of a group actually learn the material instead of simply taking credit for the efforts of their teammates. After all, one of the primary purposes of cooperative learning groups "is to make each member a stronger individual" (Johnson, 1999). Exploring cooperative learning as a pedagogical approach, then, implies that you must also explore the methods for enforcing individual accountability for learning. How do you make sure that each individual learns each course objective when the students work in teams? How do you prevent the "social loafer" who is content to let everyone else do the work while receiving the same grade? How do you prevent the over-bearing member who so dominates group discussions that others stop attempting to contribute? The answers to these questions have been explored in recent research and will be the focus of this survey.

ENGLISH

MAJ Todd Burkhardt
Title: *Measuring Theoretical Continuity: Fundamental Concepts Throughout Successive Core Courses*
Authors: MAJ Todd Burkhardt, MAJ Nathaniel Redden
Introduction: According to the English Department, "Cadets progressively improve in writing ability from EN101 to the last English core course in ways we can measure and demonstrate." While cadet writing certainly gets better over the four successive courses the Department requires, the same progressive improvement is not as visible in terms of the cadets' retention of important course concepts. This distinction is significant, especially if you agree that the Department has other value for cadets besides its mandate to improve their writing ability. In this case, achieving the same progressive improvement for *concepts* requires much more of the student as he or she progresses from one class to the next—perhaps most basically that the student internalize a certain level of foundational knowledge and then recall the same in a successive course to further enhance the learning of subject material.

But as we taught our respective courses, EN101 (Composition) by MAJ Redden and PY201(Philosophy) by MAJ Burkhardt, our conversations in the office began to reveal a suspicion that the implied continuity between core courses fell short of our Department's explicit and implicit expectations. Consequently, we began to explore assessment techniques with which to investigate the theoretical continuity between our two English Department courses. We then assessed our classes with this specific question in mind: Did the students who received certain instruction in EN101 demonstrate any measurable advantage in PY201 over students who did not receive the same instruction?

MAJ Nathaniel Redden
**Collaborated – see joint entry under MAJ Todd Burkhardt*

LTC Michael Stoneham
Title: *"Making the USMA Library a Valued Educational Resource"*
Author: LTC Michael Stoneham
Abstract: At West Point, our undergraduate students have a remarkable array of learning resources available to them. Not only do they have nearly unlimited access to their professors and instructors, they have a wide range of dedicated staff and faculty members committed to making their academic experience profitable. These educators work hard to help our students learn to study efficiently, research methodologically, and communicate effectively so that their products reflect both their intellectual engagement and their learning. Traditionally, college libraries facilitate these kinds of learning by providing students a hub of intellection—a physical location conducive to efficient learning and a trained staff who can both assist students in their efforts to develop learning skills and ensure that the library environment inspires intellectual and cultural growth. The USMA library serves this function at West Point; however, it does not always satisfy the desires or needs of our students—our primary library clients. In fact, many of our students suggest that the library is of very little value to them; some cadets even celebrate the idea that they have never been to the library. Both this troubling cadet boast and the failure of our cadets to recognize that the library is a kind of intellectual catalyst reveals that our students may not understand the potential educational value of our library and that we may be neglecting certain intellectual or cultural opportunities that our students value. Inadvertently, we may be failing to create the kind of culture that inspires intellectual excellence by failing to do certain things that make our library valuable to our students.

This oversight inspired this study, an examination of current cadet use, understanding, and value of the USMA Library. This examination revealed that among the many misapprehensions about our students, the belief that the majority of our students did not value the library is completely wrong. Instead, a significant number of our students both regularly use and readily admit that library is crucial to their educational experience. They suggest, however, that there are certain things that the library ought to change in order to make it both a more attractive facility and a more valued site of intellectual and cultural growth. Many of these suggestions are insightful and valuable. After reviewing them with the USMA Library Committee, these suggestions will be presented to the Head USMA Librarian, who has expressed his sincere commitment to ensuring both the vitality and the excellence of the current library and the future learning center.

G&EnE

MAJ James F. Chastain
Title: Portents of Success: A Correlation Analysis of Cadet Achievement in Physical Geography
Author: Major James F. Chastain
Abstract: The purpose of this research was to find quantitative indicators of future cadet success in an Academy core course, EV 203 Physical Geography. This was a longitudinal study correlating fourth year academic performances in the areas of Math/Science, Social Science, and fourth year aggregate grade point averages to their future third year academic performance in EV 203 Physical Geography. We found that the best predictors were aggregate grade point averages, PL 100 General Psychology, and CH101/102 General Chemistry.

LTC Mark Smith
Title: *Integrating assessment and instruction to better improve map reading training of New Cadets*
Author: LTC Mark Smith
Introduction: Assessments draw together information from homework, tests, and evaluations of cadet performance to make improvement in lesson design and changes in instruction (Boston 2002). Assessments can provide information relative to the attainment of the expected goals of the curriculum (Watson 2007), and to gain clear information about student understanding (Garrison and Ehringhaus). Where the results of an assessment identify areas of weakness, these areas can be appropriately addressed to make improvements. How well an assessment can be used to direct future lesson improvements, however, is related to both the accuracy of the assessment methodology (how closely the assessment method assesses performance), and its precision (how specifically it can identify areas that are in need of improvement). If accurate and precise, an assessment methodology can be used to predict future areas of subsequent success or failure and as a tool to make improvements in education.

Each summer New Cadets at the United States Military Academy at West Point, NY undergo summer training to improve their field military skills. One field skill that is particularly emphasized is land navigation. Land navigation is an essential task in which Army officers must be competent. However, during Cadet Field Training (CFT) in the summer of 2005, the percentage of cadets that received a first time No-Go on the day land navigation day course was up 3% from the previous six year average of 21% and the percentage of cadets that found all points was 15% lower than the previous six year average of 26% (Senn 2005). One reason given for the poor scores was a suggestion that the cadets had not gained the proficiency required to read a map. During their freshman year, cadets take a semester's long course (MS 101) during which they are taught the basic tasks required for map reading. At the end of the semester, they are tested, and graded and their proficiency assessed. However, because the number of first time No-Gos had increased during 2005, this semester long course was believed to be inadequately preparing cadets for CFT land navigation. As a consequence, a new Map Reading Course was begun during Cadet Basic Training (CBT) summer of 2006 as a way to give cadets additional training in map reading.

This paper reports on the CBT map reading course begun during the summer of 2006, and evaluates how well the assessment of this training was incorporated into subsequent academic year training (AY 071). This paper also provides a discussion on the lessons learned, how closely the assessment method can identify specific areas that are in need of improvement, and how assessment can be better incorporated into map reading training at West Point.

HISTORY

MAJ James Doty
Title: *Online Reading: The Perceptions and Practices of Cadets in an Advanced History Class*
Author: James L. Doty III
Abstract: This study found 80-90% of students reported they preferred to read a paper book/document compared to a digital version of the document viewed on a computer screen. This preference remained stable throughout the semester of study. When assigned two different readings for the same lesson, one presented as a paper copy of a book, and the other presented as a digital file to be read online, students consistently read the paper reading assignment more than they read the digital reading (by 10-20%). However, reading rates for lesson assignments solely consisting of digital files were no different from reading rates for lesson assignments solely consisting of paper copies of books or articles.

MAJ Raymond Kimball
Title: *"Making History": Podcasting in the USMA World History Course*
Author: MAJ Raymond Kimball
Introduction: The purpose of this project was to evaluate the feasibility of integrating podcasting into the USMA Freshman World History course. This course is a two-semester introduction to both the development and interaction of world civilizations and the historical method. For the purposes of this paper, I will use the *New Oxford American Dictionary* definition of podcasting as "a digital recording of a radio broadcast or similar program, made available on the Internet for downloading to a personal audio player." The focus will of this paper will be on the creation and content of such digital media rather than the technical means of delivery, such as RSS feeds.

The ubiquitous nature of portable media devices and our students' increasing familiarity and comfort with them leads inevitably to a desire to harness them for teaching purposes. This meshes nicely with Cashion's first element of encouraging student motivation, "Begin Where the Students Are." Podcasts have been used for introductory classes at other institutions, most notably Duke University, as described in the *Duke University iPod First Year Experience Final Evaluation Report.* At Duke, the focus was predominantly on instructor-generated content that students could access as a means of overcoming limited contact with the professor. Since USMA provides significantly more contact with the teacher, I decided to focus my podcasting on student-generated content that could be shared with other students. In this way, I wanted to reinforce a key idea of the course: historical study is in large part about argument and interpretation of evidence rather than a single truth or set of truths.

MAJ Jason Palmer
Title: *Reading Length and Lesson Efficacy*
Author: *MAJ Jason Palmer*
Introduction: Advanced History of the Military Art (HI351) changed markedly from the basic core course, History of the Military Art (HI301) in the Fall Semester of AY 06-07. The modifications to readings were ambitious in breadth and depth—only six readings from the previous year's course reader were retained. We did not use Robert Doughty's, et al, *Warfare in the Western World* at all, replacing it with Russell Weigley's *Age of Battles* and James McPherson's *Ordeal by Fire*. The intent in replacing the course's primary text was to increase the level of analysis and depth of discussion in the course. The difficulty level of the new readings was greater than in Doughty's *Warfare in the Western World*, and the concepts addressed were correspondingly wider and called for analysis in place of understanding from the reader.

The length of assigned readings was a primary concern in course design, repeated not infrequently during senior instructor oversight in the course design process. Department leadership imposed a limit of 34 pages per lesson, with an average reading load of less than 28 pages per lesson over the course. Two Academy level restrictions were the source of these impositions: that cadets complete out-of-class assignments in two hours or less for each lesson and that cadets not be assigned homework out of class beyond the readings themselves. In order to meet Academy and Department level requirements, several readings were modified during the course design process.

A primary concern in assessing the new course was the amount of time cadets actually spent on the new reading assignments and the efficacy of the new readings in achieving the course objectives of (1) drawing conclusions and forming opinions based on a critical analysis of historical evidence, and (2) acquiring an "historical mind": detecting differences as much as similarities between cases; avoiding analogies; looking for continuities but also discontinuities; and, identifying the important questions to ask. A key assumption made during course design was that because cadets were literally hand-picked for the course based upon high GPA and/or expressed interest (history majors), they were more likely to be motivated and to do the higher level readings. Subcourse and end-of-course assessments measured cadet

preparation and reading efficacy; each were tailored beyond standardized (Academy wide or Department wide) assessments.

LAW

LTC Shelley Econom
Title: *Copyright Challenges in Higher Education* (Literature Review)
Author: LTC Shelley Econom
Introduction: Innovations in technology and the pressures of globalization challenge traditional concepts of copyright law. Laws change with changing times, however, and copyright law is evolving to meet the needs of the emerging information economy. It is essential for those who use copyrighted works in academic institutions to understand not only the essentials of copyright law but also the fundamental principles upon which the copyright system is founded.

Copyright law is part of intellectual property law, which governs rights in ideas or information. The four areas of intellectual property protection are distinct but related and include patent, copyright, trademark/trade dress, and trade secret. Tangible property has long been recognized by human society as something worthy of protection. The Fifth Amendment to the United States Constitution prohibits the taking of private property without just compensation. Common law, civil law, and criminal law each protect private property from interference or taking by others. Ideas or information, on the other hand, are less tangible and protections evolved more slowly.

COL Gary Tidwell
Title: *Psychological Foundations of Teaching and Learning: Student Motivation by Sectioning Students* (Literature Review)
Author: COL Gary Tidwell
Introduction: The sectioning of students, which is often accomplished by some measure of perceived academic ability or achievement, remains among the most hotly debated and contested topics in American education - just as it has been for nearly a century. Different terminology has been used to describe the sectioning of students. Terms such as clustering, group clustering, ability grouping, and tracking, leveling, and peer tutoring all have connotations and represent variations involving the sectioning of students by some method other than a random distribution.

This paper defines each of the methods used to section students by methods other than random selection, and then examines the issues relating to each method, the history of the various practices, and the beneficial as well as the controversial aspects of each practice. It should be noted that academic research in this area of higher education has led to mixed results and recommendations, sometimes with the same research used in support of both sides of an argument.

MATH

MAJ Jong Chung
Title: *Integrating Technology into the Classroom* (Literature Review)
Author: MAJ Jong Chung
Introduction: We are living in the world of quickly advancing technology. Since the advent of the Internet and personal computers, we no longer compete with the people next door, city, or state but with the people around the world. We have a generation of students who have very different social experiences growing up through the changing times. They are used to surfing the Web looking for interesting information and things to buy. They post their photos and blogs to share with other members of global community. They frequently send and receive text messages and emails to family and friends via wired and wireless networks. Many educators argues that the only way to continue our dominance

and prosperity in the world economy and politics is to educate our people as competitive and creative members of the global community, and the proper integration of technology in our education system is crucial to accomplish the goal. Numerous research papers, articles, and books were written on integrating technology into the classroom, and they often couple it with the 'constructivist' learning theory. Many of them focus on using technology to enhance teacher-student communication and to promote collaborative and active learning, which calls for a dramatic paradigm shift from the lecture based education model.

MAJ Thomas M. Deveans
Title: *Is WebAssign An Effective Tool To Supplement Undergraduate Mathematical Learning? An Exploration Assessing WebAssign Using Student and Instructor Feedback*
Authors: MAJ Thomas M. Deveans, MAJ Heather A. Jackson
Introduction: The United States Military Academy (USMA) has reformed its mathematics curriculum to focus on student problem solving through the application of mathematics to open-ended problems. The success of our curriculum reform is frequently challenged by our students' inability to demonstrate proficiency in the mathematical skills considered fundamental to further learning in mathematics. Without an understanding of the basics, students are handicapped in their ability to problem solve. Specifically, many of our students are challenged by their limited exposure to or their inadequate retention of skills in algebra, geometry and pre-calculus. Over the past two years, we implemented strategies to address these weaknesses and have assessed student progress in these skills. This paper will examine, from both the student and instructor perspectives, whether or not WebAssign is an effective tool for augmenting classroom activities intended to contribute to students' learning or re-learning the fundamentals.

WebAssign has been used by universities and colleges across the country since its creation in 1997. More recently, at the United States Military Academy, it has been used in the Physics and Mathematics curricula to enhance student learning. WebAssign is an "online homework, quizzing, and testing management system."[1] The web-based system allows instructors to establish assessments which students can access from any internet ready computer. Once online, students have the ability to open assignments and submit their responses, receiving immediate feedback in most instances. Furthermore, the system automatically reflects student scores in instructor grade books, and allows teachers to ascertain both how a student performed and how a student responded.

MAJ Randal Hickman
Title: *Improving Undergraduate Calculus Students' Learning through Ability Group Sectioning*
Author: MAJ Randal Hickman
Abstract: This research considers the merits of ability group sectioning in a college calculus curriculum. While the larger issue of ability group sectioning is well-studied for middle school and high school students, this research addresses the less-studied question of ability group sectioning for college students. We consider three metrics in our analysis: statistical differences in final exam performance, student opinion surveys, and faculty perspectives. This paper presents both the benefits and the concerns of a college-level ability group sectioning policy within the context of the mandatory integral calculus course at the United States Military Academy. We conclude that ability group sectioning increases calculus students' learning for students of all ability levels, and the policy is strongly supported by both student and faculty opinions.

MAJ Heather A. Jackson
**Collaborated – see joint entry under MAJ Thomas Deveans*

PHYSICS

MAJ Geoffrey Bull
Title: *Constructivism and Active Learning* (Literature Review)
Author: MAJ Geoffrey Bull
Introduction: Constructivism, and its close relative, discovery theory, is an offshoot of cognitive theory that proposes learning will occur as a person actively processes information to construct solutions to problems. Literature on cognitive theory is quite extensive concerning the education and learning in children, much of it written from a child psychology point of view or starting point. In more recent years, educators have been expanding the principles to higher education.

Almost from the moment we are born, we begin to learn, absorbing information, and, eventually drawing conclusions about, i.e., learning, how the world around us behaves. Watching this process in very young children can be among the most amazing and rewarding experiences for new parents. For decades, cognitive theorists have proposed many explanations for how children learn from a very young age. The understanding of this learning process could then possibly be applied to learning at any age. The "natural" process by which a child learns, without any training at all, ought to be applicable to a trained mind as well.

The basics of cognitive theory are considered to have begun with John Dewey (1933/1998). In the mid- and latter-twentieth century, Jean Piaget and Jerome Bruner were among the leaders in forwarding the constructivist subset of cognitive theory. Bruner posited that discovery leads one to become a constructionist (Anglin, 1973). Processing stimuli from a problem that has been presented and working to a solution fundamentally lead to learning in the problem solver. Learning occurs as the solution is discovered. This learning requires that certain facts must already be known, but the discovery leads to new insights concerning the relationship between various facts that are known.

MAJ Steven Cho
Title: *Predictors for Success in Physics*
Author: MAJ Steven Cho
Abstract: Different departments use different methods to select cadets for enrollment in advanced sections of core course classes. Furthermore, some departments resection their classes after major graded events in order to group students with similar abilities. Both of these practices attempt to predict overall academic performance for each student upon course completion. This brings to bear an underlying question: How can we predict success in our courses? In this paper, I present results from an analysis of cadet performance in the two-semester core physics course in order to determine any possible predictors for success in physics.

MAJ Chad Giacomozzi
Title: *Questioning Techniques* (Literature Review)
***Author*:** MAJ Chad Giacomozzi
Summary: Questioning techniques are a key element of the interactive classroom which are constantly being invented and revised to help facilitate active learning. Active learning puts the responsibility of learning on the learners themselves, and has been championed by Charles Bonwell and James Eison in their 1991 report *Active Learning: Creating Excitement in the Classroom* as a method to increase student retention of material. Questioning when used effectively can also serve as an assessment technique, helping teachers determine what students know and understand.

SOCSCI

MAJ Thaddeus Underwood
Title: *Technology in the Classroom: Is it worth it?*
Author: MAJ Thaddeus Underwood
Abstract: This paper addresses the use of technology in one of the core courses at the United States Military Academy, SS201/SS251 - Introduction to Economics, and how the use of a new technology known as Aplia, online based economics courseware, affected the students' performance in the course. *Specifically I will address how using online testing combined with hard copy testing affected student grades.*

While I believe that technology as a whole enhances education, I believe that if not used properly, its benefits will not be fully realized. My hypothesis in writing this paper is that combining on-line testing with hard copy testing on the same exam will yield inferior results than you would see with an all hard copy test, specifically in the Introduction to Economics Course. I used data from 4 semesters of testing with data from over 2100 tests to yield my results.

The end result supported my initial overall hypothesis, and for follow on research I would like to look at data for the homework portion of the course, which was based on the Aplia software, and relate it to test scores.

FULL-TEXT MODELS

Literature Review

Questioning Techniques

By MAJ Chad Giacomozzi
Department of Physics

Questioning techniques are a key element of the interactive classroom which are constantly being invented and revised to help facilitate active learning. Active learning puts the responsibility of learning on the learners themselves, and has been championed by Charles Bonwell and James Eison in their 1991 report *Active Learning: Creating Excitement in the Classroom* as a method to increase student retention of material. Questioning when used effectively can also serve as an assessment technique, helping teachers determine what students know and understand.

This paper will highlight and contrast some of the most commonly used modern questioning practices in order to help instructors more effectively use questioning as a pedagogical strategy. Teachers have been using questions as a means to assess their students since the development of the Socratic Method around 400 BC to challenge assumptions, expose contradictions and lead students to new knowledge and wisdom. Questioning techniques, however, made their boldest entrance into the forefront of teaching discussions in the mid 20th century with Benjamin S. Bloom's *Taxonomy of Educational Objectives: The Classification of Educational Goals* (1956). Here Bloom separated the cognitive domain into six categories, which form the basis of most modern questioning techniques. More recently, Bonwell and Eison (1991) redefined the term "active learning," and in doing so caused the teaching community to embrace innovative questioning techniques in order to improve the learner's ability to retain knowledge and increase their level of thinking.

Ronald T. Hyman states in his book *Strategic Questioning* (1979) that "teaching is essentially a verbal activity" and that "questioning is essential to teaching; both for the teacher and the student." Because of this, modern questioning techniques rely on developing open-ended questions that facilitate interactive discussion in the classroom. Leslie Blair declares in her article, *The Right Questions Can Improve Student Thinking and Learning* (2002), that "teachers often ask closed-ended questions that don't allow the students to demonstrate their level of knowledge or lack of knowledge. The quality of a student's response is affected by the quality of the question's contents, how the question is asked, and the pacing of the question."

One can easily argue that the "quality" questions suggested by Blair are ones that stimulate higher-order thinking. Higher-order thinking is defined by Ervin F. Sparapani in *Encouraging Thinking in High School and Middle School: Constraints and Possibilities* (1998) as "thinking creatively, critically, or in a decision making or problem solving manner." It is also defined by L.B. Savage in *Eliciting critical thinking skills through questioning* (1998) as "formulating generalizations from the information learned and then substantiating those generalizations."

There are many systems in educational literature used to create and classify questions. According to William W. Wilen over 21 such classification systems existed at the time he wrote his book *Questioning Skills for Teacher* (1991). Wilen presents his own taxonomy that separates questions into four quadrants with paired criteria. According to Wilen, questions can either be low or high-order and they can either be convergent or divergent in their design. Low and high-order questions refer to the type of thinking they stimulate, where the terms divergent and convergent refer to the limits placed on the response to the question. Convergent questions may also be referred to as

"closed-ended" questions, meaning that there is generally one accepted answer to the question. Divergent questions are open ended by nature, and not only require a student to recall knowledge from memory but also how to apply that knowledge to explain, extrapolate or further analyze a topic or problem. Lower level convergent questions require the learner to recall or recognize information like definitions, identifications and quotations. Higher level convergent questions require the learner to apply information by comparing, contrasting, describing, explaining, summarizing, interpreting, or providing examples to answer the question. Lower level divergent questions require students to think critically about ideas and information by allowing them to discover causes, draw conclusions or make inferences and generalizations to answer the question. Lastly, higher level divergent questions allow students to make predictions, speculate, construct and devise lifelike problems and their solutions, express opinions and make choices and decisions.

Hyman (1979) proposes a simple framework to aid in the construction of effective questions, which consists of three different categories of questions. These categories are organized to assist in building questions that stimulate higher-order learning. The first category contains definitional questions, which involves lower order thinking because they require nothing more than memorization to answer. Empirical questions are the second category which consists of both facts and relationships between facts. The former of which requires lower order thinking, while the latter requires higher order thinking because the learner must make comparisons, explain causes and make predictions. The last category contains evaluative questions consisting of both opinions and justification of opinions. Making an evaluation based on one's opinion involves lower level thinking, whereas justification of that opinion is considered higher level thinking. Using this framework, effective questions would be ones that ask learners to express relationships among things and to justify or support their opinions.

Jill Slack, from the Southwest Educational Development Laboratory, created a workshop entitled *Teaching Thinking Through Effective Questioning* (2007) which is designed to develop questioning skills. She breaks questions into two groups: core questions and processing questions. Slack describes the attributes of each group of question and provides examples of each. Core questions are used to cue and direct the interactions in the classroom. Processing questions are also referred to as probing questions, and are themselves broken down into six categories: refocusing questions, clarifying questions, verifying questions, redirecting questions, narrowing the focus questions and supporting questions. She provides an excellent questioning process map consisting of examples of core and processing stems of questions.

It is a commonly held belief that using a mixture of types and levels of questions in the classroom yields the most beneficial experience to the learner. Proving the relationship between the cognitive level of a teacher's questions and the achievement of their students, however, has been a point of controversy. Many studies have found higher level questions superior to lower level ones, while some have found the opposite, yet others have found no difference.

Most problems that occur in the classroom are not because of inherent flaws in these questioning systems, but in teaching pedagogy itself. Wilen reports that only 5% of teacher directed questions are higher level divergent. While these systems provide an excellent breadth of questions to ask and we know that asking multiple types of questions is good pedagogy, educators consistently revert back to asking lower level convergent questions far more than any other type of question. The first step to overcoming this problem is for educators to ask themselves what kind of questions they are asking, why they are asking them, and finally which of the many questioning techniques they can utilize to make their classroom better.

The following are recommendations for good questioning practice:

1. Consider your instructional goals for the lesson and plan some questions designed to direct the flow of the lesson, but do not be afraid to use un-planned questions to steer the conversation.
2. Ask clear and specific questions that cannot be answered with a simple yes or no. Communicate the question so that the learner understands what kind of response is expected.
3. Sequence questions so that they build upon each other. Use a balance of questions from all types and levels.
4. Encourage responses from both volunteering and non-volunteering students to gain maximum participation. Redirect initially asked questions to other students to cultivate discussion.
5. Probe initial student responses and encourage students to clarify and support their answers.
6. Pause anywhere from 3 to 15 seconds after asking a question to give students time to formulate their answers. Also pause after students' initial responses to give other students a chance to interpret that response.
7. Respond to answers in a positive, sincere way to create a risk free environment. Guide incorrect answers with additional questions or rephrase your question in such a way that it is better understood.
8. Require students to generate questions of their own.

The techniques listed above are straightforward and most instructors are already familiar with them; however, many fail to use them regularly. Regular application of some of the questioning techniques mentioned could greatly enhance the learning environment of any classroom.

Annotated Readings:

Blair, Leslie. (December 2002). The Right Questions Can Improve Student Thinking. *Southwest Educational Development Laboratory,* 14(3), 20-22.
This is an excellent article that summarizes Jill Slack's SEDL workshop entitled *Teaching Thinking Through Effective Questioning*. Blair provides a strategy to construct effective core questions in outline form, as well as examples of core questions to use in eleven different roles: observing, recalling, comparing, contrasting, grouping, labeling, classifying, sequencing, inferring causes, inferring quality and predicting. She describes and also provides several examples of each of the five different kinds of processing questions: refocusing, verifying, redirecting, narrowing the focus, and supporting. At the end of her article is a very useful annotated bibliography.

Bloom, Benjamin S. (Ed.). (1956). *The Taxonomy of Educational Objectives: The Classification of Educational Goals.* New York, NY: David McKay.
This is the book that revolutionized the way educators think about learning. Almost all modern questioning techniques are derived from Bloom's work. He divides educational objectives into three domains: affective, psychomotor and cognitive. The success of most questioning techniques relies on understanding the cognitive domain and its hierarchical structure. The lowest to highest order cognitive domain objectives are: knowledge, comprehension, application, analysis, synthesis, and evaluation. Some researchers argue against the hierarchical nature of his taxonomy, but almost all agree on its six categories. In order to properly use questioning techniques, teachers must first understand their students and know why those techniques are applicable.

Bonswell, Charles C., & Eison, James A. *Active Learning: Creating Excitement in the Classroom.* ASHE-ERIC Higher Education Report No. 1. Washington, DC: The George Washington University, School of Education and Human Development.
This is the quintessential article on active learning. They cover four major issues: what is active learning and why is it so important, how can it be incorporated into the classroom, what are the barriers, and what conclusions should be drawn and recommendations made. They make a call for teachers to be well versed in questioning techniques and strategies, particularly the ones pioneered by

Ronald Hyman. In order to use any questioning technique or strategy effectively, one must first understand why they are so important.

Brookfield, Steven D., & Preskill, Stephen. (2005). *Discussion as a Way of Teaching: Tools and Techniques for Democratic Classrooms.* San Francisco, CA: Jossey-Bass.
This book is full of classroom examples from different disciplines. It covers many different tools and techniques that can be incorporated into almost any classroom. There is a chapter dedicated to ensuring that students come to class prepared and contains exercises designed to help prompt students to talk. Two chapters are devoted to preparing for and starting discussions, and two more to keeping discussions going. There are also more conceptual topics covered in other chapters, such as balance of voice and speech patterns.

Hyman, Ronald T. (1979). *Strategic Questioning*. Englewood Cliffs, NJ: Prentice-Hall.
This book is written for educators and its purpose is to help you become an effective, strategic questioner. Hyman provides a simple framework for constructing effective questions. Chapter Four is designed to help organize your questions. Chapter Five gives fifteen specific questioning strategies. Chapter Six is essentially a training manual with numerous scenarios designed to help improve your teaching, probing, learning and dialoging skills.

McKeachie, Wilbert J., & Svincki, Marilla. (2006). Facilitating discussion: posing problems, listening, questioning. In *McKeachie's teaching tips: Strategies, research, and theory for college and university teachers* (pp. 35-55). Boston, MA: Houghton Mifflin Company.
This book as a whole is an excellent blend of theory backed by practical suggestions. McKeachie invites other nationally recognized authors to write specific chapters of his book. One such chapter by Svincki tackles discussion and questioning techniques. The author covers various methods used to start and lead discussions, how to overcome the barriers to discussion, and how to handle arguments and emotional reactions. This is a very easy to read book, and each chapter has its own annotated references for further study. This book also has a short section covering online discussions, which are becoming more and more popular.

Stahl, Robert J. (May 1994). *Using "Think-Time" and "Wait-Time" Skillfully in the Classroom*. Bloomington, IN: ERIC Clearinghouse for Social Studies/Social Science Education of Indiana University.
This is an excellent article that examines the topic of wait-time and think-time in great detail. Stahl discusses the importance of the three second threshold as a "breakthrough-point" and gives his "Eight Categories of Periods of Silence." He describes in great detail how to use these eight categories of periods of silence: post-teacher question wait-time, within student's response pause-time, post student's response wait-time, student pause-time, teacher pause-time, within teacher presentation pause-time, student task completion work time, and impact pause time. Lastly the author summarizes his article with his recommendations for skillful use of think-time.

Walsh, J. A., & Sattes, B.D. (2005). *Quality Questioning: Research Based Practice to Engage Every Learner*. Thousand Oaks, CA: Corwin Press.
This is a very easy to read book that gives practical, research based techniques designed to enhance teaching in the classroom. It uses very clear examples and provides tools to guide teachers in their construction of questions. The authors offer strategies designed to engage every student with a question as well as prompt them to generate their own questions. At the end of every chapter, there are useful questions for reflection and quotes from various teachers.

Wilen, William W. (Ed.) (1987). *Questions, Questioning Techniques, and Effective Teaching.* Washington, DC: National Education Association.

This is an edited collection of nine papers. It provides a review of pertinent research on questioning techniques in Chapter Two. Chapter Four discusses the characteristics, purposes and values of the different kinds of questions. Chapter Five discusses wait time and how it can be used advantageously in the classroom to produce different effects. It describes the characteristics, principles, types and phases of classroom discussions in Chapter Seven and provides a research based approach to improve questions and questioning skills in Chapter Nine.

Wilen, William W. (1991). (3rd Ed.). *Questioning Skills, for Teachers. What Research Says to the Teacher*. West Haven, CT: NEA Professional Library.
This book discusses Wilen's research findings on teachers' questioning practices and student generated questions. Wilen discusses the impact of these questioning practices on student thinking, achievement and attitudes. This book provides an approach using two analysis forms, "Question Levels" and "Questioning Techniques," that teachers can use to gather information in self-evaluation of their own questioning behaviors.

Additional Resources:

Camp, William G. *Improving Your Teaching: Questioning Techniques*. Vol. 66, No. 5. Agricultural Education Magazine, Nov 1993. 17-23.
Finkel, Donald L. *Teaching with your mouth shut*. Boynton/Cook Publishers Inc., 2000.
Harris, Robin Lee. *Batting 1,000: Questioning Techniques in Student-Centered Classrooms*. Vol. 74, No. 1. Clearing House, Sep-Oct 2000. 25-26.
Hunkins, F.P. *Involving Students in Questioning*. Allyn & Bacon, 1976.
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Hyman, R.T. "Fielding Student Questions. Theory into Practice." Vol. 19, No. 1. *Teaching Methods: Designs for Learning*. Winter, 1980. 38-44.
Hyman, R.T. *Improving Discussion Leadership*. Teachers College Press, 1980.
McComas, William & Abraham, Linda. *Asking More Effective Questions*. Retrieved 15 May 2007 from the University of Southern California, Rossier School of Education website: www.usc.edu/programs/cet/private/pdfs/usc/Asking_Better_Questions.pdf
Patterson, Michelle. *Questioning Techniques*. Vol. 8, No. 1. Teacherlink, 1999. 14-16.
Savage, L. B. *Eliciting Critical Thinking Skills Through Questioning*. Vol. 71, No. 5. Clearing House, May-June 1998. 291-293.
Slack, Jill. Teaching Thinking Through Effective Questioning. Retrieved 15 May 2007 from the Southeast Educational Development Laboratory website: www.sedl.org/secac/rsn/thinking.pdf
Sparapani, Ervin F. *The Effect of Teaching for Higher-Level Thinking: An Analysis of Teacher Reactions*. Education, Fall 2000.
Zander, A.F. "The Discussion Period in a College Classroom: Memo to the Faculty." No. 62. *Center for Research on Learning and Teaching*. The University of Michigan, March 1979.

Literature Review

Class Attendance: Mandatory or Optional?

By COL Leon L. Robert, Jr.
Department of Chemistry and Life Sciences

"*80% of success is showing up.*" - Woody Allen

Class attendance in undergraduate courses is a frequent topic of discussion among students, professors, and administrators. Although this diverse group at any university would probably never agree on any present or proposed attendance policy, they probably would agree that class attendance is far from perfect. Class attendance (or absenteeism) is a major concern for educators at many institutions of higher learning (Devadoss and Foltz 1996). College students enjoy many academic freedoms, including the decision whether to attend specific classes on any given day since attendance in college is not mandated by law. If academic success correlates with high rates of classroom attendance, then why do some college students choose to skip class?

Extent of classroom absenteeism

Absenteeism is a significant problem at many colleges and universities (Romer 1993). Daily absenteeism in college classrooms has been shown to be as high as one-third to almost one-half of students in certain disciplines (McGuire 2003, Moore 2003a, 2003c, 2005). This is especially true in introductory science classes (Friedman, Rodriguez and McComb 2001). Romer (1993) quantitatively investigated the links between absenteeism and various characteristics of classes. He found that smaller classes had less absenteeism; the more significant the mathematical component of the course, the less the absenteeism; there was more absenteeism in introductory courses than in upper level courses; the better quality of the instruction, the less the absenteeism; and absenteeism was mainly concentrated in a few students who missed many classes while most students rarely missed classes. White (1992) suggested that student absenteeism adversely affects the overall "well-being of classes." Subsequent research expanded this concept by suggesting that absenteeism creates a "dead," tiresome, and unpleasant classroom environment, thus making students who come to classes feel uncomfortable and professors' irritable (Brauer 1994). This absenteeism persists even though over two-thirds of professors believe that students are unprepared for college (Thomas 2002).

So why do students choose to skip college classes? There are probably as many reasons as there are college students. However, a recent survey of undergraduates at Massachusetts Institute of Technology (Clay and Breslow 2006) reported that the most important factors (in order of precedence) in deciding whether to attend lectures are the lectures' quality and clarity, conflicting deadlines for other classes, the professor's use of relevant examples, and the professor's ability to engage and entertain students. Students' responses to this survey seem to suggest that they use a practical decision-making process that considers many factors in deciding what classes to attend and how often. The primary factor involving quality and clarity of lectures seem to support the need for educators to continually seek creative and innovative teaching methodologies to increase class attendance (see Broder 1994 for review).

Many students complain of bored-sounding professors simply reading from PowerPoint presentations or from a book. Some students believe that since they pay for classes, they should be the ones to decide whether or not to attend classes, and should not be penalized for failing to show up (Maizel 2006). Some students even suggest that they can learn more from not going to class (Schoenbrum 2007). They believe that instead of wasting time being bored and distracted in classes, they can sit down on their own, focus, and learn the material.

New digital media is an emerging concern and possible contributor to student classroom absenteeism (Shapiro, Mentch and Kubit 2007). These media include user-published blogs, video clips, collaborative wikis (a collaborative website which can be directly edited by anyone with access to it), and immersive virtual reality. Some faculty fear that class attendance will drop if the course is supported by digital media such as webcasts. However, one student survey of 431 students indicated that videos were not the reason that 70% of students missed classes. Only a small percentage of students reported that they skipped classes and used videos as an alternative to lectures. Interestingly, 75% of students surveyed indicated that they used videos as a review tool and were most likely to review videos before quizzes and tests. Most of the students that reviewed videos indicated that they were doing better in classes because of the videos.

Many students intuitively know that it is important to attend class. Moore (2003b) found that more than 90% of students in introductory science classes know on the first day of classes that they have a better chance of receiving a higher grade if they regularly attend class. However, many students believe that the importance of attendance to academic success should be linked to receiving credit for attending class. Also, their attendance rates drop if they do not receive credit for attending class (Launius 1997, Moore 2003b).

Some college administrators believe that class absenteeism is linked to extra-curricular activities such as athletics, social activities and drinking. At the University of Alabama, 24% of high-absence students stated partying too hard was the reason they missed classes. School administrators are looking for ways to work with surrounding bars and businesses to improve class attendance. In addition, 20% cited part-time work as the reason they missed many classes (Gasner 2002).

College is a time in life when students should begin to develop adult and "business like" behaviors to prepare them for their adult working lives. They should learn that in the business world showing up late continually or not showing up at all can lead to being fired. Similarly, they should view class attendance as their "job" and be ready and willing to show up on time for class and be ready to work. Also, late comers and no-shows to class can place heavy burdens on professors time outside of class and in the business world they place similar burdens on co-workers.

Will classroom attendance improve academic success?

Early research on the relationship between attendance and grades was mixed. A number of studies demonstrated a relationship between high attendance rates and high grades (Brocato 1989, Launius 1997, Moore 2003b, Thomas and Higbee 2000). Research of economics students indicated that effort and intelligence determined the grade, while student's attendance record and the student's overall value of the course were less important in determining the grade (Park and Kerr 1990). One study reported that classroom attendance does not affect academic performance (Berenson, Carter and Norwood 1992). One early study even suggested that mandatory attendance could have a negative effect on student learning and grades (Hyde and Flournoy 1986).

Research on attendance in economics classes at three different universities indicated that class absenteeism can run as high as one-third of students (Romer, 1993). This research also provided quantitative data that suggests a positive correlation between attendance and learning. While controlling for grade point average and completion of problem sets, the difference in performance between students attending classes regularly and students attending sporadically was approximately one letter grade. In contrast, previous research (Park and Kerr 1990) reported that effort and intelligence were the most important determinates of grades in economic courses and student attendance played a less important role. Recent studies in economics classes indicate that attending lectures corresponds to a significant improvement in exam performance by as much as 7.7% (Chen and Lin 2006, Lin and Chen 2006).

There is some evidence that underperforming students who do not attend introductory classes have a more difficult time in the upper-level courses in their majors (Brauer 1994). This observation lends support to those schools that have mandatory attendance policies for freshman classes. Historically, a high percentage of freshmen have struggled to make the transition from high school to college. The increased freedoms of college life can be a constant distracter from the rigors of academia. To assist with this transition, many colleges and universities have mandatory dormitory residence policies for freshman to help minimize the distractions of independent living off campus.

Some first-year students fail to understand that academic success relies on both attendance and effort. Currently, entering freshmen spend less time studying than previous entering classes, but have higher grades (Sax et al. 2002). An increasing percentage (46%) of freshman had an A average in high school despite the fact that many (33%) studied less than 6 hours per week (Young 2002). In addition, a significant percentage (16%) of freshman acknowledge that they study less than one hour per week. High school students with poor study habits are increasingly rewarded with higher grades and therefore feel that they should be given the same high grades when they exert the same minimal efforts in college. Because of these expectations, the entering college freshman has a high probability of encountering grade disappointment during the first year.

Some universities are considering taking attendance in 100-level classes and recording the information. This information would possibly be used to help settle some recurring conflicts between parents and school officials. Increasingly parents call schools wondering why their student who made As in high school, is making Ds in college. They blame the school for neglecting their students' education and thus failing to fulfill the school's obligation to each student.

Ways to improve attendance and academic success

For class attendance to have the most academic value, both students and teachers must be actively engaged. Students will accomplish little or nothing academically if they only come to class to socialize, complete work for other classes or activities, or sleep. Students must choose to participate in their own education and take responsibility for their learning. Class attendance does not guarantee success, but can enhance the probability of academic success.

Teachers too have an obligation to students to present informative and exciting material that keep students interested and engaged. Professors should provide an appealing and exciting classroom environment and thus providing value-added knowledge in class. This value should extend beyond what non-attending students can get from reading the textbook and study guides on their own. This value-added knowledge should matter to students and improve their education and knowledge base. In addition, problem sets and tests should be aligned with lectures. In addition, demonstrations also help to relate lectures to the "real" world by visual stimulation.

Most professors do not assign grades based solely on students' attendance, but rather on students' mastery of course content. However, some professors try to ensure high attendance rates by using pop quizzes, taking attendance, or giving away test questions in class. Although, these methods can force students to attend, these methods are viewed as "cheap" and "mean" by some students (Clay and Breslow 2006). Some professors feel that they personally invest in every student by going far beyond the expected duties of teaching and that students should reciprocate by going to class (Niklewski 2006). Other professors believe that students who do not go to class are not interested in learning, but rather just want to get a degree (from a diploma mill) to show a prospective employer.

Even if a teacher is intellectually stimulating and provides clear lessons, explanations and examples, some students will not be motivated enough to come to class. Teachers and advisors must make students cognizant of the benefits of attending class. They must show students the empirical

relationship between attendance, grades, and academic success. Despite the best efforts of teachers, the high-risk student who has no real interest in learning and who does not attend classes will have a low probability of success. Perhaps these students have not yet learned that making personal decisions about their priorities and responsibilities have far-reaching consequences in life.

Attendance feedback (Gaudine and Saks 2001) is one interesting technique used in an attempt to improve class attendance. The rationale for attendance feedback is that most people tend to underestimate their own absenteeism and overestimate the absenteeism of other students. The hypothesis is that when students receive feedback documenting their absences as well as the average number of absences of other students over the same period, their attendance will improve after receipt of a feedback letter. One recent study reported that course grade point average significantly correlated with attendance after the use of attendance feedback letters (Broucek and Bass 2007). This study adds further evidence that grades are strongly linked to attendance.

Although, administrators, teachers, and students opinions are at odds about class attendance policies, research supports a strong link between classroom attendance and grades. This finding would seem to also be linked to overall educational success. Research indicates that attendance is statistically significant in explaining class grade and overall student performance. A student who frequently misses class will decrease their chances of receiving a high grade in a given course. Current research supports the idea that faculty should strongly encourage attendance with quality teaching and emphasizing the empirical relationship between grades and attendance. However, it is important to remember that correlation does not mean cause and effect. Attendance alone will not guarantee student learning and high grades.

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Annotated Readings:

Broder, J. M. (1994) Empiricism and the art of teaching. *Journal of Agricultural and Applied Economics, 25 (July), 1-18.*
This is an excellent review of some of the major findings of empirical studies on teaching and the teaching evaluation process. Broder also discusses the art of teaching by providing some insightful personal tips that made his teacher experience more regarding. He identifies teaching characteristics that are important to students. Faculty members are encouraged to use their analytical skills to diagnose their teaching efforts. He suggests that students choose to attend class for a purpose and that they appreciate high quality instruction that helps them achieve that purpose. Faculty evaluation plays a vital role in education and should be a shared responsibility between teachers, students, and administrators.

Chen, J. and T. Lin. (2006) Class attendance and exam performance: a randomized experiment. *Society of Labor Economics (SOLE) Eleventh Annual Meetings*, May 5-6, 2006, Cambridge, MA.
Chen and Lin provide an excellent review of literature of the determinants of exam performance based on class attendance. Their careful, randomized experiment provides strong quantitative evidence for the link between classroom attendance and grades on exams. These results and previous research should be part of any faculty members

Devadoss, S. and Foltz, S. (1996) Evaluation of factors influencing student class attendance and performance. *American Journal of Agricultural Economics, 78, 499-507.*
This study quantifies the effects of student behavior, teacher attributes, and course characteristics on class attendance and performance. This work reinforces the earlier work of Romer strengthening the empirical evidence of the positive influence of class attendance on student performance. These authors present a clear challenge to educators to find and implement suitable measures to increase class attendance. This article provides a detailed list of strategies for faculty, advisors, and administrators to reduce absenteeism and enhance student performance.

Moore, R. (2003a) Does improving developmental education students' understanding the importance of class attendance improve students' class attendance; academic performance? *Research & Teaching in Developmental Education, 20, 24-39.*
_____ (2003b) Helping students succeed in introductory biology classes: Does improving students' attendance also improve their grades? *Bioscience, 29, 17-25.*
_____ (2003c) Students' choices in developmental education: Is it really important to attend class? *Research & Teaching in Developmental Education, 20, 42-52.*
_____ (2005) What factors predict success of developmental education students in an introductory biology course? *Research & Teaching n Developmental Education, 21, 35-42.*

Moore's work takes a critical look at the relationship between academic success and how it correlated with high rates of academic success in introductory science classes. He provides a detailed review of the literature and provides strong quantitative evidence that academic success is significantly correlated with high class attendance. He also presents data that indicates that high of class attendance are an excellent predictor of future academic success. This work is logically sequenced and provides clear and concise conclusions based on current research.

Tai, R. H., Sadler, P. M., and Loehr, J. F. (2005) Factors influencing success in introductory college chemistry. *Journal of Research in Science Teaching*, 42: 987-1012.
This interesting research explores the link between high school chemistry pedagogical experiences and performance in introductory college chemistry. The conclusions are based on a survey of 1,531 students enrolled in first-semester introductory college chemistry courses for science and engineering majors at 12 different U.S. colleges and universities. Although, this study does not specifically address classroom attendance, it does emphasize that students must be present and engaged in the classroom to learn. However, they did quantify "encouragement" to take science and to attend classes as a predictor of academic success. This research is a serious attempt to sort out the effects and influences of the various indicators of success in college introductory chemistry courses.

Classroom Research Project

Commercial Breaks in the Classroom

By MAJ Seth Norberg
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Introduction

After teaching a required undergraduate thermal-fluids systems course to a broad assortment of engineering students, many of whom saw no point in their enrollment in the course, I attempted various methods to spur their interest, keep their attention, and liven the discussion. The tipping point was during my second semester when I taught a majority of students (90%) who would not take the follow on course or subsequent courses in mechanical engineering. I saw the value in developing a rapport with the students and also answering the "so what" question that the challenging student so often poses. In short, I saw the necessity of the commercial break in the class room.

Research shows that the college age student initially has a 15-20 minute attention span which becomes shorter as the lecture progresses [5] & [10]. Further research showed that students recalled 70% of the information presented in the first 10 minutes of class and only 20% from the last ten minutes [6].

Changes in the environment recruit attention. The ability of changes to capture attention can work to the advantage of the lecturer. Variation in pitch, intensity, and pace of the lecture, and visual cues such as gestures, facial expression, movement to the blackboard, the use of demonstrations or audiovisual aids—all of these recruit and maintain attention to the lecture.—McKeachie [6].

Expanding on McKeachie's statement and focusing on changing the environment, I realized that many of the demonstrations, slide shows, movies, and stories could be pre-planned to coincide with lulls in the lecture. The primary means of instruction was writing on the blackboard. Based on McKeachie's recommendation, the commercial break served as a means to change the environment. Depending on which students had drank their morning coffee, the breaks to either maintain or recruit their attention. These breaks consisted of demonstrations, slide shows on the topic, engineering stories, military stories, or personal stories pre-programmed for at least once during the 55 minute lecture.

Examples

The demonstrations ranged from a cold can of soda (showing closed vs. open system) to an exploded view of an air conditioning Brodhead-Garret device.

Slide shows included PowerPoint slides of photos of the topic or key points. For the Bernoulli equation / pitot-static class, photos of pitot tubes on different aircraft were show. Typically the slides were used when the device analyzed was too large to be a demonstration.

Engineering stories consisted of my limited experiences in the lab or working in industry. Background history on how an experiment was conducted or the scientist behind it also worked well. Joule's experiment proving that the internal energy of an ideal gas is a function of temperature alone provided an opportunity to discuss Joule. The term "horsepower" and James Watt were another well received story.

Military stories attempted to show the concepts from class in military technologies as well as soldier initiatives—cooling water bottles by putting them in a wet sock highlights evaporative cooling and was shown to me by one of my NCOs. The cadets crave information on all aspects of military life.

Personal stories included, "so there I was driving through the middle of Texas in July and my engine temperature gage was moving up fast—What did I do?" to highlight how an engine is cooled as well as

the occasional topic of the day, "why are you so tired today?" and the response of "there was a surprise inspection at 0400 this morning."

Regardless of the type of commercial break, the environment of the class needed a change from board work. By stepping away from the blackboard, their pencils went down and their eyes came to me.

Survey Overview

The students were asked for feedback at the end of the semester on five types of commercial breaks (demonstration, slide show, engineering story, military story, personal story). The first question asked how "effective" they found that type of break ranging from 1-5 (one being the lowest score and five being highest). The second question asked how "enjoyable they found that type of break. Four free text questions followed asking "which type of break did you find the most effective"; "which type of break did you find the least effective"; "comment on the overall attempt of introducing commercial breaks"; and "give any suggestions for future commercial breaks".

First Iteration

Fall semester of 2006 (AY07-1), the author had two sections of Thermal-Fluid Systems I (ME311). Based on the plan introduced earlier, during the majority of the lessons, some type of commercial break was conducted. During an early lesson in the semester, an impartial visitor remarked, "the class actually perked up the last ten minutes of class" following a demonstration of a closed system with a work input that resulted in a temperature rise within the closed system.

The results from the semester are shown below, the two sections were asked how effective the commercial breaks were and how enjoyable on a scale from one to five.

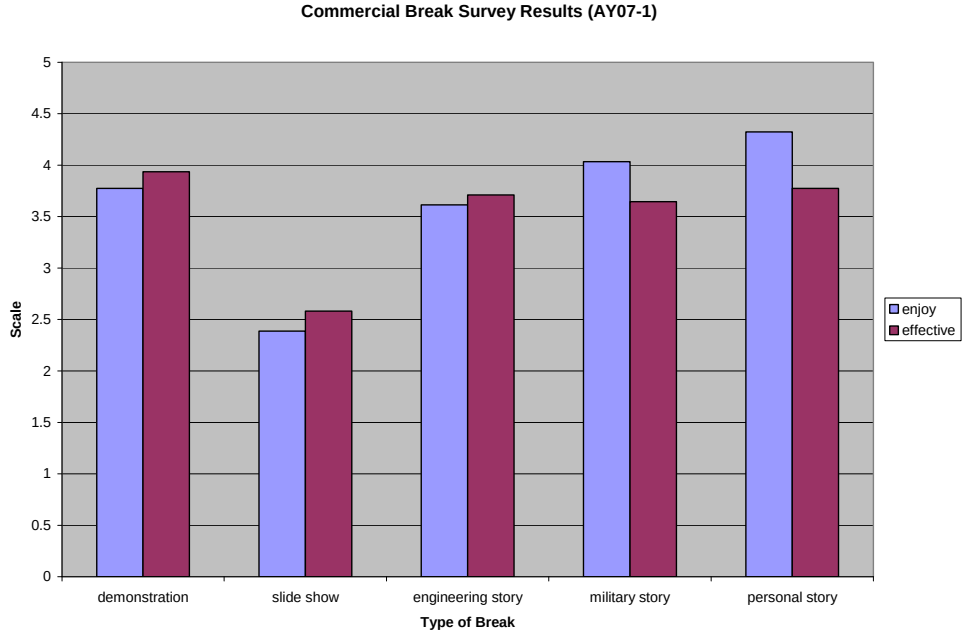

Figure 1: Commercial Break Survey Results from Academic Year 07-1

As expected, demonstrations were more effective than enjoyable and personal stories were more enjoyable than effective for the class.

"Visual demonstrations helped to make concepts more understandable and applicable"

"Demonstrations were great because it solidified the theoretical concepts of what we learned."

Prior to conducting the survey, my initial thought was the effectiveness of the demonstration would be rated considerably higher than any of the stories, especially personal story. However, that was not the case. Each of the stories was relatively effective and considerably enjoyable.

"I think they (stories) were refreshing. They actually got me interested again."

Second iteration

Heartened by the feedback from the initial attempt at commercial breaks, I decided to continue using commercial breaks despite teaching a new course during Spring semester. Keeping the same format for the survey, the trends as far as enjoy vs. effective remain the same, however, the overall score was markedly higher. As a group, the students were much more receptive to the personal and military stories. One interesting side note is that the incoming GPA for the spring semester students was considerably higher than the incoming GPA for the fall semester.

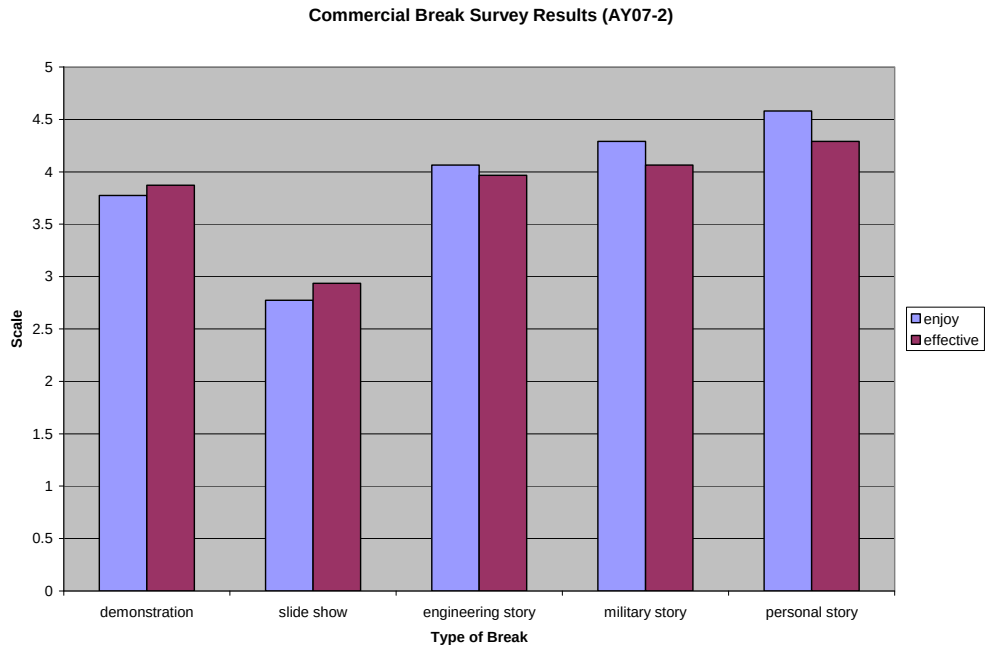

Figure 2: Commercial Break Survey Results from Academic Year 07-2

Feedback Analysis

The first free text question asked the students to comment on the most effective commercial break: 30% said demonstration and 37.5% said personal story which supports the results in figures 1 and 2. Interestingly, the second semester found the personal stories more effective than the demonstrations. Needing the breaks to wake up, the first hour of the day section contributed most to those results.

The least effective commercial break was the slide show that was detested by the majority (45%) of cadets. From personal experience, once started, two or three students would almost instantly start fading. One student comment referenced *"death by PowerPoint"* in a previous course as to the immediate disdain for the medium. While slides in general were not well received, videos were requested by 36% of the students.

"Slide shows really do not catch my attention very well. I think it is a bi-product of military science."

An additional two questions requesting comments on the attempt and suggestions for future commercial breaks yielded some interesting responses. There were no negative responses regarding the overall attempt (93% positive).

"The off beat pace and other 'aside' were a great way to keep me into class."

Suggestions for future commercial breaks included requests for more videos (36%) and having the students lead the breaks—so instead of my planned break, let a student bring a demonstration (I had one student bring a modified potato cannon to show how pressure drives flow) or tell the story.

An additional source of feedback is the academy survey collected at the end of each semester. Shown in Figure 3 is the reason for the introduction of commercial breaks (highlighted in the data from AY06-2). The feedback continued increasing after the second installment, spring semester, of commercial breaks. One reason for the possible increase is the break was often taken when the class "decided" it needed one.

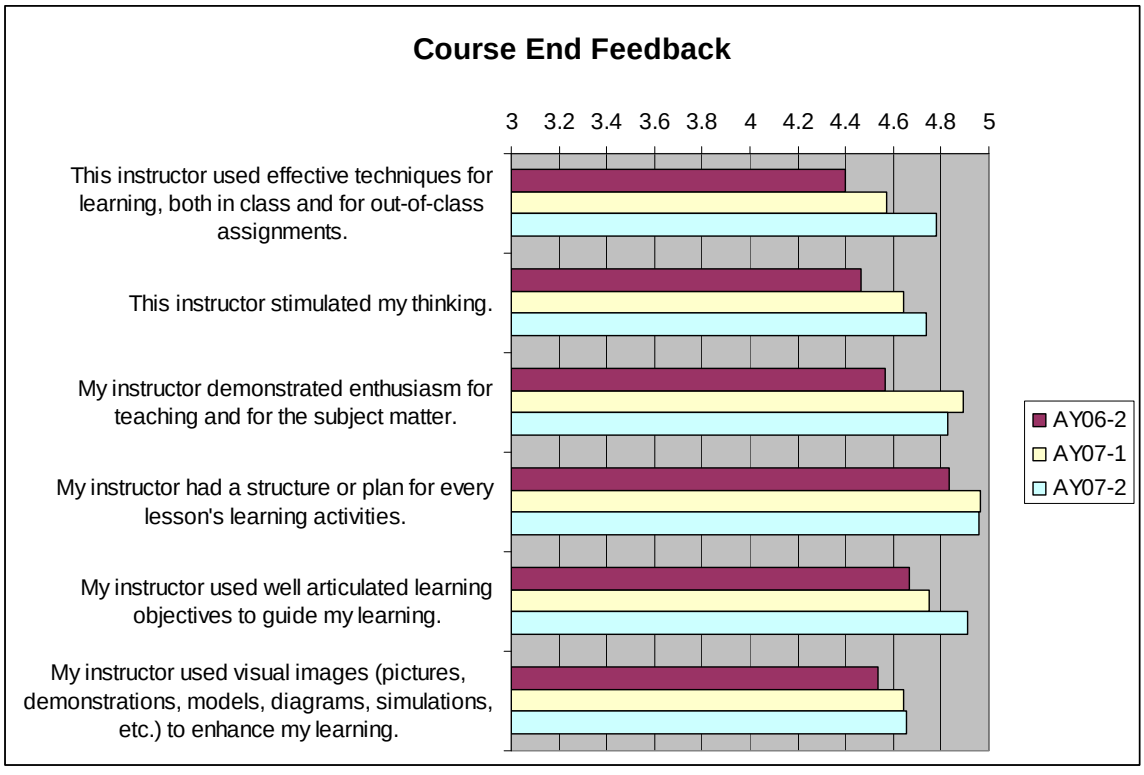

Figure 3: Course end feedback for AY06-2, AY07-1, and AY07-2

"Good introduction into commercial breaks, usually let us dictate how / when we would take a natural break which was good"

One unintended by-product from these commercial breaks, in particularly the stories was the increase in interpersonal rapport with the class. Lowman [7] introduces a two dimensional model of effective college teaching that has two dimensions: intellectual excitement and interpersonal rapport. Despite Middendorf and Kalish's [5] protests to the contrary, these stories served to break the ice with the class and jump

started rapport building. Often the stories lead to students staying after class to continue the discussion. Designating a few minutes to showing your personal side every couple of lessons will not diminish your level of intellectual excitement, but it will do wonders for your interpersonal rapport with the class.

"Personal story—it is fun to see what Seth (the author) is like behind the greens."

"I like how you interact with us and show personality. Many teachers don't."

By raising the interest level of the class, the performance of the students increased as well. Over the two semesters teaching the course, looking at the incoming GPA of the section to the outgoing GPA of the section, the overall GPA raised each semester. Compared to the course incoming versus outgoing GPA, the effectiveness of the commercial breaks is inconclusive.

Shown in Table 1 below, each section had a positive GPA increase and was equal to or above the overall course enrollment increase with the one exception of the already extremely high incoming GPA of G hour of ME312. The impact on the academic performance of the commercial breaks can be debated—it is about equal to the increase of the entire course enrollment. However, the feel of the class and the rapport developed made the semester more enjoyable for both the students and the instructor and did not impact on academic performance.

	ME311			ME312		
	G Hour	I Hour	Course	G Hour	I Hour	Course
Incoming	3.2	3.08	3.16	3.6	3.25	3.32
Outgoing	3.29	3.24	3.26	3.67	3.52	3.44
Increase	0.09	0.16	0.1	0.07	0.27	0.12

Table 1: Student GPA by section and compared to course

Conclusions

The students appreciated the effort as indicated in the 93% positive responses to the overall attempt. The majority found commercial breaks to be an effective and enjoyable way to break the class. The commercial breaks also expedited development of rapport with the class. The students were more attentive and livelier after the break and the class was much more enjoyable for everyone. In addition, the performance of the sections was at or above the overall course performance.

"I liked the relaxed atmosphere of the class because it made it more fun to learn. Also, I liked the "commercial breaks" because they broke up the material and made it seem more personal than West Point generally does. I also enjoyed all of the material."

"Excellent addition to the classroom environment."

Acknowledgment

This work was conducted in collaboration with the United States Military Academy (USMA) Master Teacher Program, offered through the USMA Center for Teaching Excellence (CTE), West Point, New York. The support of Dr. Mark Evans, CTE Director and Dr. Kimberlee Bonura, CTE Assistant Director is gratefully acknowledged.

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Classroom Research Project

Ability Group Sectioning in an Undergraduate Calculus Curriculum

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Introduction:
The purpose of this research is to offer a fresh perspective on the ability-group sectioning debate, the long-standing discussion regarding whether or not students benefit from sectioning them by ability. Two specific aspects of my research separate it from the majority of other papers on this subject. First, my research focuses on a university setting, considering the relative merits of ability-group sectioning in a required calculus course at the United States Military Academy. Second, I base my conclusions on a broad analysis of student surveys and faculty surveys, in addition to a statistical analysis of test scores with and without ability-group sectioning. I conclude that ability-group sectioning was enormously successful in the calculus curriculum at West Point, as evidenced by a statistically significant improvement in test scores for students of all ability levels and strongly supportive feedback from students and faculty alike.

Literature Review:
The controversial topic of ability-group sectioning is well-studied in the academic literature. A quick search will yield a plethora of papers passionately arguing either for or against this sensitive issue. In [6] and [7], Loveless provides a thorough overview of the ability-group sectioning and tracking debate. His works offer a history of sectioning and/or tracking programs and numerous specific examples of both successful and unsuccessful policies. His works were especially helpful in highlighting both the perceived benefits and the perceived problems associated with ability-group sectioning and tracking. The most commonly argued benefits and concerns are described below in greater detail.

Arguments in favor of ability-group sectioning:
Most of the arguments in support of ability-group sectioning focus on the importance of providing the most gifted students with the opportunity to study in ability-groups. In [4], Kulik and Chen-Lin offer a fervent endorsement of ability-group sectioning for gifted students. They argue that the achievement level of gifted students would dramatically decline without ability-grouping of some form. Kulik and Chen-Lin suggest that ability-grouping does not hurt the self-esteem of average or below average students, but that a lack of sectioning (or tracking) could have long-term negative social effects on the performance of gifted students. They argue that we (as a society) cannot afford to stop offering accelerated educational opportunities to extremely gifted students, since “no one can be certain that there would be a way to repair the harm that would be done” if we did not offer gifted educational opportunities. Murray further endorses this perspective in [8], arguing that “our future depends crucially on how we educate the next generation of people gifted with unusually high intelligence.”

Century’s research in [1] indicates that it is important to let gifted students work together collaboratively for long periods of time. Although Century expresses some concern for students in lower-ability groups, the long-term collaboration needed by gifted students is most easily achieved in an ability-grouped classroom environment. In [14], Swiatek argues that average or below average students may experience an increase in self-esteem when sectioned with students of similar abilities. She also suggests that gifted students learn much more when grouped with other gifted students. In such an environment, there are fewer distractions to an accelerated rate of learning. Spear supports this notion in [13], explaining that ability-grouping is supported by “subject centered” teachers. Spear also indicates that many teachers prefer ability-grouping because it is easier to teach an academically similar group.

Arguments against ability-group sectioning:
The majority of the academic research strongly opposes ability-group sectioning. The principle concerns focus on the harm caused to lower-than-average students when they are placed in lower-performing ability-groups that have a lower expectation for long-term success. In [3], Hoffer found that middle school students who were placed in lower-level mathematics ability groups ultimately had lower expectations for success in high school math. This discouraging outlook on the subject resulted in a lower overall performance in high school math. Linchevski and Kutcher found that average and below-average students performed much better when placed in mixed-abilities sections [5]. This was most obvious when their achievements were compared to the less successful accomplishments of their intellectual peers who were placed in homogeneous ability-groups. In [2], Greenwood argues that peer-tutoring can be a very effective learning method for "at-risk" students. This technique requires an intentional mixture of ability groups to allow brighter students to tutor struggling students.

Oakes, Ormseth, Bell, and Camp offer a particularly strong argument against ability-group sectioning in [9]. In order to give all students the opportunity to later succeed, they argue that all students need equal access to a high-quality education. Early placement in lower ability-groups dramatically affects a student's long-term ability to overcome this initial placement. They argue that this is especially prevalent among low-income and minority children, and that the practice of ability-group sectioning in inherently unfair. Century's work in [1] supports the concern that minorities and low-income children are disproportionately represented in lower-tracked ability groups.

In [10], Roe and Rodebaugh's research indicates that most middle-school faculty prefer heterogeneous grouping because it improves class culture. They argue that heterogeneous ability-grouping has positive social benefits, positive behavioral implications, and academic benefits due to the social nature of learning and peer learning. Slavin supports this view in [11], suggesting that there is increased cooperative learning resulting in higher achievement when students learn in heterogeneous groups. Slavin argues that this is achieved with "little or no psychological harm, and less segregation." In [12], Slavin states that the effects of ability grouping on student achievement are minimal. Since this is true, Slavin argues, "there is little reason to maintain the practice." In [13], Spear also suggests that "student centered" teachers generally oppose ability-group sectioning.

Summary of Literature Review:
As we consider the existing literature on ability-group sectioning, two important observations arise. First, many of the papers that consider ability-group sectioning or tracking argue principally from the perspective of theoretical pedagogy or faculty experience. My research considers the input of faculty members, but it also includes two of the most important sources of information that many studies ignore: input from the students and the statistical analysis of test scores with and without ability-group sectioning. While the theoretical discussion is important, a more careful analysis of consumer (student) opinions and test results offers stronger evidence of whether or not ability-group sectioning benefits the student population.

The second observation is that almost all of the existing research focuses on students in elementary school through high school. There is seemingly a void when it comes to research on ability-group sectioning at the undergraduate level. The reasons for this are clear. When a student pursues post-secondary education at most colleges, his or her academic program is designed (*tracked*) according to the ultimate degree program of his or her choice. If this even includes a mathematics course, there is almost never any effort to section by ability-group. In some sense, these college students have already "sectioned" themselves according to their chosen major and their academic interests. On a very practical level, the students at most colleges often control which sections they are enrolled in based on preferred instructors, convenient class times, or other scheduling conflicts. This would make institutional ability-group sectioning impossible or highly impractical at most colleges.

As is often the case, however, we find ourselves in a seemingly unique situation at USMA. Armed with both the capability to populate sections by ability-groups and the genuine desire to improve the cadets' learning experience whenever possible, we should consider whether ability-group sectioning improves cadet performance in academics.

Background:
I conducted my research in the Math Department at the United States Military Academy. All cadets must complete (or validate) a challenging math curriculum that includes math modeling, differential and integral calculus (in single and multiple variables), probability, and statistics. My research addressed the relative merits of an ability-group sectioning policy in the required Yearling course in integral calculus (MA205). This class was a prime candidate for ability-group sectioning because of the broad spectrum of calculus experience observed in our student body. Many of the cadets arrive at West Point with a strong calculus background (pre-calculus courses or AP Calculus experience from high school). However, many of our students also start lesson one of this course having never seen an integral symbol in their previous math classes. Furthermore, the large enrollment (approximately 800 students) relative to the small class size (18 students per section), allows for a well-defined, homogeneous level of academic ability in each section if ability-group sectioning is employed. Finally, historical analysis of cadet grades has shown that this particular course has proven to be a very challenging course for many cadets. By structuring sections according to ability groups, the intent was to focus the educational experience of each section towards the needs of the students in that particular section. Hopefully, this would improve the overall course experience for all cadets.

Before continuing, I should clarify that this research is focused on ability-group sectioning, not on *tracking*. Tracking is a technique where students are "tracked" into different curriculums based on their abilities or academic interests. Examples of tracking at USMA include the advanced curriculums offered to selected cadets in many of the core-courses. At other universities, examples of tracking may include different versions of a required mathematics course (of varying complexities) that support different majors (a general calculus course vs. calculus for engineers). While the tracking debate is an interesting source of academic discussion, the focus of this research is on ability-group sectioning.

Ability-group sectioning is a technique where students study a common curriculum, but classes are organized according to ability-groups. At West Point, we achieve ability-group sectioning by organizing the sections of a core-course according to previously-measured academic ability. The course director can accomplish this goal by choosing to automatically populate sections in the Academy Management System (AMS) according to CQPA. Since CQPA also includes military and physical scores in addition to academic scores, the course director can refine the sections through a manual process as needed.

For this research, the course director for MA205 populated the sections based on CQPA, but all sections studied the same curriculum. All sections also used the same course-wide assessments. In particular, all of the cadets in MA205 (regardless of their section) had the same Term-End Exam, the same Projects, and the same WPRs. The goal of this research was to determine whether or not ability-group sectioning improved cadet performance in MA205.

Although the Yearling calculus course has been in existence for many years, the course experienced content changes in 2005. During the first year of the revised calculus course, a test group of 188 students studied under the revised curriculum. This group of 188 cadets was randomly selected from the top two-thirds of the cadet year-group (as indicated by their performance on the math placement exam.) During the second year, (2006), the new curriculum was used for all cadets, and cadets were randomly assigned to sections without ability-group sectioning. During the third year (2007), the new curriculum was again

used for all cadets, but cadets were assigned to sections based on their cumulative academic GPA (their class rank) at the start of the semester.

Results:
The results of this research come in three forms: a statistical analysis of test scores, student survey results, and faculty survey results. We will consider each in turn.

Statistical Results:
My initial goal in this research was to determine whether or not there were any statistically significant differences in academic performance between the three years. Since the course-end grades include group projects and homework assignments that change from year to year and are graded by a variety of different faculty members, I was concerned that it would be extremely difficult to isolate the effect of ability-group sectioning versus a variety of confounding factors if we consider final grades. In response, I only considered the students' performances on the final exam. This exam was virtually unchanged during the three year period, and it is always graded by a faculty team to ensure equity of grades across the course. It is also a very challenging, comprehensive exam that serves as a good measurement of overall student understanding of course material. Table one shows the descriptive statistics for the three years of final exams.

	Without Sectioning (top 2/3 only)	Without Sectioning	With Sectioning
Year	2005	2006	2007
Mean	81.22%	68.88%	78.27%
Median	83.08%	68.94%	79.00%
Standard Deviation	10.85%	12.46%	11.58%
Minimum	9.16%	12.24%	40.50%
Maximum	98.16%	97.88%	99.67%
Number of Students	188	836	847

Table 1: Descriptive Statistics of Final Exam Performance

Table 2 shows the percentage of students who earned each of the possible letter grades on the final exam during the same three years.

	Without Sectioning (top 2/3 only)	Without Sectioning	With Sectioning
Year	2005	2006	2007
Percentage A Grades	16.49%	4.19%	17.59%
Percentage B Grades	49.47%	16.15%	29.40%
Percentage C Grades	19.68%	25.72%	27.63%
Percentage D Grades	9.04%	15.43%	11.57%
Percentage F Grades	5.32%	38.51%	13.81%

Table 2: Final Exam Performance by Letter Grade

We will first consider only the years 2006 and 2007 when the entire cadet population studied under the revised curriculum. Both the mean and the median for 2007 (with ability-group sectioning) are approximately ten percentage points higher than in 2006 (without ability-group sectioning). While the percentage of C grades remains relatively constant in both years, table two shows us that the percentage of A and B grades is much higher (and the percentage of D and F grades is much lower) when students

were sectioned by ability. This seems to contradict the most common criticism of ability-group sectioning, the notion that ability-group sectioning benefits the strong students at the expense of the weak students. Rather, my data shows that the number of D or F grades on the final exam decreased by more than twenty-eight percent when students were sectioned by ability. This surprising result occurred when everything else in the course (other than the use of ability-group sectioning) was held constant. The same curriculum and the same final exam were used both years. Furthermore, the student body was made up of similar, high-quality cadets both years. In fact, the entrance exam scores on the math sections of both the SAT and the ACT were essentially identical for both year-groups. [16]

An even more remarkable result becomes apparent when we compare the final exam results from 2007 (with ability-group sectioning) to the final exam results of the test group in 2005. Recall that the test group was a random selection of 188 cadets who scored in the top two-thirds on West Point's math placement exam, while the 2007 group included the full spectrum of cadets. However, the performance of these two groups is statistically very similar. In fairness, almost all of the key statistics in Tables 1 and 2 (mean, median, and percentage of each letter grade) are better for the test group in 2005 than for the full student population with ability-group sectioning (in 2007). However, the students in 2007 (with ability-group sectioning) were statistically much more similar to test group in 2005 (students from the top two-third of their class) than they were to the full student body in 2006. This suggests that one of the statistical effects of ability-group sectioning is to "pull-up" the bottom one-third of a student body such that the overall performance of the entire collection of students is statistically similar to the "upper two-thirds" of a student group that does not experience ability-group sectioning.

I used Minitab statistics software to conduct an Analysis of Variance calculation (ANOVA) on the final exam scores for each of the three year-groups to determine the strength of the statistical significance of these results.

One-way ANOVA: 2007, 2006, 2005

Source	DF	SS	MS	F	P
Factor	2	4.6899	2.3449	165.17	0.000
Error	1868	26.5204	0.0142		
Total	1870	31.2103			

S = 0.1192 R-Sq = 15.03% R-Sq(adj) = 14.94%

Individual 99% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	+---------+---------+---------+---------
2007	847	0.7827	0.1158	(--*-)
2006	836	0.6888	0.1246	(-*--)
2005	188	0.8122	0.1085	(-----*-----)

+---------+---------+---------+---------
0.680 0.720 0.760 0.800

This output reinforces the strong statistical difference between the three years. The low p-value (0.000) shows that there is essentially 0 % chance that such a difference in performance can be attributed simply to random processes.

A separate comparison of 2007 scores to 2006 scores is below. This removes the effect of the test group in 2005, and isolates the comparison between 2006 test scores (without ability-group sectioning) to 2007 test scores (with ability-group sectioning).

One-way ANOVA: 2007, 2006

```
Source   DF      SS     MS      F      P
Factor    1  3.7090  3.7090  256.37  0.000
Error  1681  24.3196  0.0145
Total  1682  28.0285

S = 0.1203   R-Sq = 13.23%   R-Sq(adj) = 13.18%

                    Individual 99% CIs For Mean Based on
                    Pooled StDev
Level    N    Mean   StDev  ----+---------+---------+---------+-----
2007   847  0.7827  0.1158                        (---*--)
2006   836  0.6888  0.1246  (---*--)
                  ----+---------+---------+---------+-----
                   0.690     0.720     0.750     0.780
```

As expected, we see a strong, statistically-significant difference between the two years. This is especially significant since all other factors were held constant between 2006 and 2007.

A separate comparison of 2005 (test group from top 2/3^{rds} of students) to 2007 (full student body with ability-group sectioning) is below. This removes the effect of the 2006 data, and isolates the comparison between 2005 and 2007.

One-way ANOVA: 2007, 2005

```
Source   DF      SS     MS     F      P
Factor    1  0.1341  0.1341  10.22  0.001
Error  1033  13.5469  0.0131
Total  1034  13.6810

S = 0.1145   R-Sq = 0.98%   R-Sq(adj) = 0.88%

                    Individual 99% CIs For Mean Based on
                    Pooled StDev
Level    N    Mean   StDev  -------+---------+---------+---------+--
2007   847  0.7827  0.1158  (-----*------)
2005   188  0.8122  0.1085          (-------------*------------)
                  -------+---------+---------+---------+--
                     0.784     0.800     0.816     0.832
```

The p-value is still very low (0.001) indicating a strong statistical difference in the data sets. However, we see an overlap in the 99% confidence intervals suggesting that the data sets are more similar than the previous comparison between the 2006 data and the 2007 data. While the test group in 2005 outperformed the full student body in 2007, the difference in performance is much smaller than the difference between 2006 and 2007. This suggests that the full student body that experienced ability-group sectioning (in 2007) had final exam scores that more closely resembled the test group from the top 2/3^{rds} of the class in 2005 than the full student body in 2006.

Up to this point, my intent was to compare the overall performance of each of the three groups. However, since the 2005 group was made up of students from the top 2/3^{rds} of their peer group, this has been a somewhat unfair comparison. In the next section, I compare only the top 2/3^{rds} of the students from 2006

and 2007 with their peer group – the test group of students in 2005 (all of whom represented the top 2/3rds of the student population in 2005.)

One-way ANOVA – Top 2/3rds of Year-Groups: 2007, 2006, 2005

Source	DF	SS	MS	F	P
Factor	2	2.37202	1.18601	178.25	0.000
Error	1307	8.69624	0.00665		
Total	1309	11.06826			

S = 0.08157 R-Sq = 21.43% R-Sq(adj) = 21.31%

Individual 99% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	+---------+---------+---------+---------
2007	565	0.84931	0.06819	(--*--)
2006	557	0.75757	0.08346	(--*-)
2005	188	0.81218	0.10849	(----*----)

+---------+---------+---------+---------

0.750 0.780 0.810 0.840

As before, we see a very low p-value (0.000) indicating a statistically significant difference between groups. However, we now see that the students with ability-group sectioning (in 2007) clearly outperformed **both** of the other groups. I attribute some of this difference to the levels of ability-group sectioning experienced in each of the three groups. The top 2/3rds of the students in 2006 did not receive any benefits of ability-group sectioning. Not surprisingly, their scores tended to be the lowest of the three groups. The students in the experimental group in 2005 received some benefits of ability-group sectioning since all of the students in the experimental group came from the top 2/3rds of their year-group. However, there was no additional refinement of the ability-group sectioning within that group. In 2007, cadets were sectioned according to their class rank. All cadets in every class section (17 or 18 students per section) were within a very close range of academic abilities with each other. Given this ability-group sectioning strategy, final exams scores of the top 2/3rds of the students were significantly higher than the top 2/3rds of either of the other two groups.

If we consider only the top 1/3rd of the performers in each population, we see a similar result. The analysis below compares the top 1/3rd of 2006 and 2007 with the top half of the hand-selected group from 2005. (i.e. It compares the top half of the "top 2/3rds data for each of the three years.) The Minitab output is below.

One-way ANOVA — Top 1/3rds of Year Groups: 2007, 2006, 2005

```
Source  DF      SS      MS      F      P
Factor   2  0.93537  0.46768  205.38  0.000
Error  653  1.48695  0.00228
Total  655  2.42232

S = 0.04772   R-Sq = 38.61%   R-Sq(adj) = 38.43%

                    Individual 99% CIs For Mean Based on
                    Pooled StDev
Level   N    Mean   StDev  --+---------+---------+---------+-------
2007  283  0.90694  0.04067                          (--*--)
2006  279  0.82692  0.05661  (--*--)
2005   94  0.88830  0.03734                (----*----)
                    --+---------+---------+---------+-------
                    0.825     0.850     0.875     0.900
```

As before, we see that the most aggressive ability-group sectioning policy (in 2007) produced the highest test scores for the students in the top 1/3rd of their peer group. The moderate ability-group sectioning policy in 2005 produced the next highest test scores. The top 1/3rd of the randomly sectioned students (in 2006) had the lowest scores.

The comparisons above offer strong evidence that aggressive ability-group sectioning helps students in the top 2/3rds and top 1/3rd of their peer groups. However, this is not surprising. The overwhelming bulk of the literature supports this notion. The greater concern is typically with whether or not the bottom 1/3rd of students suffers at the expense of the top 1/3rd of students.

The analysis below compares the bottom 1/3rd of the final exam test scores for 2006 (without ability-group sectioning) to the bottom 1/3rd of final exam test scores for 2007 (with ability-group sectioning.)

One-way ANOVA: Bottom 1/3rds of Year Groups 2007, 2006

```
Source  DF      SS      MS      F      P
Factor   1  1.33900  1.33900  313.89  0.000
Error  559  2.38456  0.00427
Total  560  3.72355

S = 0.06531   R-Sq = 35.96%   R-Sq(adj) = 35.85%

                    Individual 99% CIs For Mean Based on Pooled
                    StDev
Level   N    Mean   StDev   +---------+---------+---------+---------
2007  282  0.64912  0.06493                           (--*---)
2006  279  0.55141  0.06570   (---*--)
                     +---------+---------+---------+---------
                    0.540     0.570     0.600     0.630
```

This Minitab output demonstrates one of the most important outcomes of this research. Cadets in the bottom 1/3rd of the student population had a dramatic improvement in their test scores when they learned calculus in an ability-group structured environment. More precisely, the average test score of the bottom 1/3rd of students increased by almost 10% when students learned calculus in an ability-group setting. This

is approximately the same increase in the mean test scores that we had previously observed in the entire population when exposed to ability-group sectioning.

The statistical evidence lends significant credibility to the position that ability-group sectioning indeed enhances student performance in an undergraduate calculus curriculum. In the next section of this paper, we will consider the most commonly overlooked aspect of the ability-group sectioning debate – the students' opinions.

Student Survey Results:
Most of the research concerning ability-group sectioning focuses on theory and expert opinion. Many studies also include some statistical evidence from test scores, with evidence supporting both sides. However, most research avoids any serious attempt to gather and understand student opinion on the subject. While the literature is rampant with *expert* opinions about how ability-group sectioning may affect student psyche, there is very little effort to survey students and record their candid opinions. This was precisely my goal in the second section of my research.

Throughout the semester, the faculty did not tell the students that they had been sectioned according to their class rank. Students in very "high" or very "low" sections may have noticed an unusual distribution of similar performers in their section, but most students later expressed no previous knowledge about their manner of sectioning. On the last day of class, the cadets were told about the ability-group sectioning strategy that had been used during the semester, and all students were given an anonymous survey with three questions on it.

1. Describe any benefits/advantages (if any) that you observed this semester due to the ability-group sectioning policy.
2. Describe any difficulties/problems (if any) that you observed this semester due to the ability-group sectioning policy.
3. Given your personal experience with ability-group sectioning this semester in your calculus class, circle one of the choices below to describe your overall opinion of the policy:
   Terrific OK Don't Care Bad Idea Horrible

Of the 847 students who took calculus that semester in 2007, 798 students attended class during the last class period and completed the survey. Given the truly anonymous nature of the survey, the cadets were remarkably candid, thoughtful, and thorough in their replies. I read each of the 798 surveys and compiled the results. Given a population as large as 798 cadets, at least one or two of the surveys included almost every conceivable viewpoint and opinion. However, the trends associated with cadet opinion became very clear: the students overwhelmingly supported sectioning their calculus classes by ability groups.

Considering the third question first, the histogram below shows the number of students who answered the question with each of the possible choices.

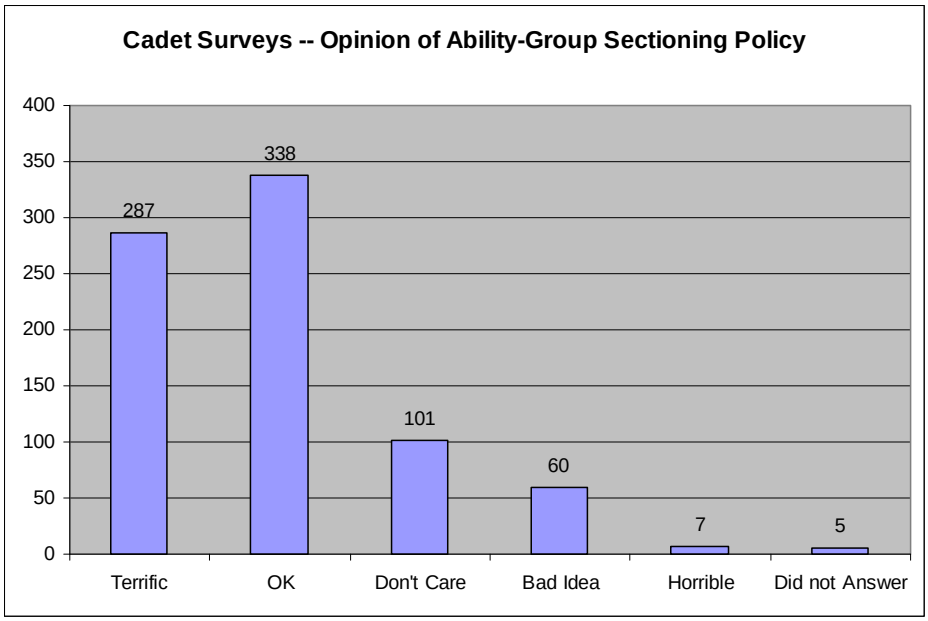

Figure 1: Cadet Survey Results – Opinion of Ability-Group Sectioning Policy

I had expected a bell-shaped curve to the histogram, anticipating that most students would reply that they did not care either way and that the less extreme statements of "OK" or "Bad Idea" would have been more frequent than the more extreme replies of "Terrific" or "Horrible." Instead, almost 36% of the students thought that ability-group sectioning was "Terrific" and another 42% said that it was "OK." Even if we combine the "Bad Idea" and "Horrible" replies, they only account for about 8% of the total responses.

The cadets' answers to the first two questions on the survey reflect the overall trend seen in the histogram. The vast majority of the surveys were very favorable of the ability-group sectioning policy. The comments below are taken from cadet surveys, and they reflect the overall trend of supportive comments. Comments such as these were typical of most cadet responses.

1. "Cadets experience similar problems, and the instructor is concerned about everybody at the same level."
2. "The benefits are enormous because the cadets are on the same level, and they can work at the same pace rather than some cadets being held up by others."
3. "No Disadvantage. The speed my class went was perfect. I am currently receiving the best math grade I have ever received."
4. "One person won't be left behind and another cadet won't be held back by slower people."
5. "The pace of learning was just right."
6. "It keeps people from being bored or uncomfortable.
7. "We all got along better, and it made class more enjoyable."
8. "We had better discussions in class."
9. "I was not scared to ask 'stupid' questions."
10. "The ability to comprehend course material was surprisingly consistent in the class. The class was more efficient because the instructor rarely had to give 'remedial' explanations in class."

Comments of this type were the norm, regardless of whether the student survey came from an "upper," "middle," or "lower" section.

The principle concerns with the ability-group sectioning policy fell into one of three areas:

1. Students in the lower sections had to work harder on projects and homework assignments because there were not any "superstars" in the class who would do the lion-share of the group work.
2. Cadets tend to form study groups with other cadets in their sections. Cadets in lower sections needed to look beyond their class section to form study groups.
3. A small group (less than 2%) of surveys expressed concern about students in "low" sections feeling discouraged either by a "low section" label or because their section (as a group) was struggling with the course content.

Interestingly, the students addressed each of these concerns in their own comments on the surveys. I will respond to each of these concerns using actual replies from the student survey.

Many of the students who expressed the first concern in their survey immediately followed that statement by a realization that they had benefited from the ability-group sectioning policy. One student in a "lower" section commented: "There were no people to do our work for us [on the projects]. We had to figure it out on our own. I think we do benefit." Another cadet mentioned that the sectioning policy "kept one person from doing all the work." Cadets recognized that this short-term challenge had long term benefits since it forced them to learn the material. This better prepared them for success on course-wide exams and the final exam. As one student from a "lower" section commented, "it made me more responsible for my learning."

While many cadets expressed some *frustration* with the second concern (difficulty forming study groups), many of these same students recognized that this was easily overcome by studying with peers in their cadet companies, sports teams, or clubs. Furthermore, several cadets in lower sections commented that they had found themselves in the position of teaching their section-mates (a wonderful new experience for many of these cadets who had not typically been in this position.) As one such cadet wrote in his/her survey: "the best way to learn is to teach."

The third concern is one of the primary objections in scholarly literature that opposes the notion of ability-group sectioning. In fairness, these concerns did manifest themselves in a small set of the student surveys. However, a fascinating realization occurred when I cross referenced these comments with the sections from which the surveys came. The vast majority of these concerns came from "higher" level sections who were expressing concern for their fellow cadets who were in "lower" sections. In some respects, these comments were oddly reminiscent of the scholarly articles written by *experts* who speak of how the lower ability-grouped students *probably* feel. While it is admirable to be concerned for these students, the reality is that the vast majority of the surveys from "lower" sections were exceptionally supportive of ability-group sectioning. Instead of discouraging students in "lower" sections, being grouped by ability with academic peers actually encouraged most of these students. Actual comments from students in "lower" sections are below:

1. "Cadets are more comfortable with asking questions in a class where everyone learns at about the same pace."
2. "I was able to communicate better – there was no identification as the 'stupid kid' in a class of stronger performers."
3. "The attitude for the students was improved. When you see someone you know of equal ability next to you doing well, you have a better confidence in doing well."
4. "Yes we benefited – there are no overly-arrogant know-it-alls who answer all the questions, draw all the teacher's questions, and intimidate the rest of the class into silence."
5. "I felt I belonged to class. Nobody was seen as too smart or too dumb."
6. "I felt more comfortable in this class."

7. "We were able to take the necessary time to ask pertinent, relative questions without pressure from more advanced students."
8. "I didn't feel as dumb as last year when there were a few people that were dominating the class."

One survey from a "lower" section described his/her ability-group sectioning experience particularly eloquently: "I felt much more confident in class, and I noticed that cadets were more willing to help each other succeed. Classes were more fun, I got more out of instruction, [I] left feeling like I understood the concepts, and [I] didn't feel stupid for asking questions. Most of the time, when I asked a question, somebody else was wondering the same thing. I did not observe ANY disadvantages."

In summary, the overwhelming majority of "lower" sectioned students were extremely supportive of the ability-group sectioning policy. In contrast to the fears of damaged psyche and discouraged performance, these students said that sectioning policy boosted their confidence, increased their classroom participation, and ultimately helped them succeed. Combined with the strong statistical evidence for their improved performance on the final exam, it becomes clear that the students in "lower" sections experienced a tremendous benefit from ability-group sectioning.

Faculty Survey Results:
A third information source used in this research was faculty surveys. Because of the large number of students enrolled (847) and the small class size (18 or fewer students per section) there were 19 faculty members teaching the calculus course in 2007 during the semester with the ability-group sectioning experiment. Each faculty member completed an anonymous survey at the end of the semester that asked a variety of questions about sectioning.

I asked the 19 faculty members to rate the ability-group sectioning policy on a scale of 1 (horrible) to 7 (terrific). The results are in the histogram below.

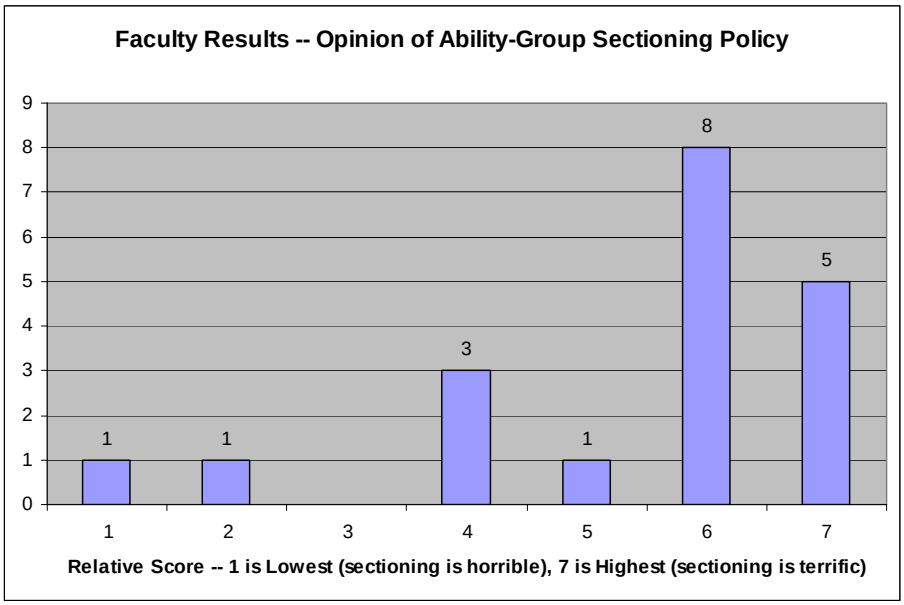

Figure 2 – Faculty Survey Results – Opinion of Ability-Group Sectioning Policy

The comments of the 14 faculty members who rated sectioning as a 5, 6, or 7 essentially mirrored the cadets' comments. These faculty members taught a mixture of "upper," "middle," and "lower" sections, and their comments included the same favorable language that dominated the cadets' responses. The 3

faculty members who rated the ability-group sectioning policy with the "neutral" score of 4 either stated that they were "unsure" or saw both benefits and disadvantages that also mirrored the comments made by cadets. I was most interested in the comments made by the two faculty members who gave the policy the low scores of 1 or 2.

The faculty member who scored ability-group sectioning as a "1" taught upper third students. This faculty member had the following comment: "It has been very beneficial to my (upper third) students. I was able to cover all the suggested materials and even some advanced materials. On the other hand, I am concerned with the cadets in the lower third, who apparently have a hard time since there are few peers to learn from." The faculty member who scored ability-group sectioning as a "2" taught a mixture of upper and lower sections. This faculty member's main concern was a lack of motivation for success in "lower" sections. This faculty member commented: "I think it is not a good idea for "F" students. However, I think advanced students could benefit greatly from sectioning."

If we consider these comments, both faculty members stated that they thought ability-group sectioning was beneficial to advanced students. Their sincere concern was for students in "lower" sections. While this concern is admirable, we must remember that one of these faculty members was speaking in theoretical terms only (having only taught in the upper sections), and that the students who were actually in the "lower" sections tended to be tremendously supportive of ability-group sectioning in spite of the concerns of these two faculty members. I appreciate the sincere concern expressed by these two faculty members, but the "lower" sectioned students replied to these concerns through their own overtly-supportive comments in the student surveys.

As a final comment, there may have been some level of teaching experience associated with the trends in the faculty responses. Although our faculty enjoys a very congenial relationship in which all are seen as colleagues, it was an interesting observation that all five of the faculty members who rated ability-group sectioning as a 4 or below on the faculty scale were members of the junior faculty. Of the six members of the senior faculty who taught calculus that semester, 100 percent rated the ability-group sectioning policy as a 5, 6, or 7 (average rating of 6.167.)

Many faculty members who read this paper may wonder about the difference in faculty workload associated with ability-group sectioning. I also addressed this concern on the faculty survey. Most faculty members said that their workload was largely unchanged or actually less because they could more easily target their student audience. Some faculty said that their work load had increased, but this was most typically associated with faculty members who were teaching sections of different ability levels. One faculty member commented: "I basically have to adjust my lesson plan for each level. It's almost like teaching three courses at once." This is a valid concern that may be addressed by assigning faculty members sections which are on a similar ability level. While some may speculate that it would be difficult to find volunteers to teach the lower sections, this was not the case in my observation. Many of our faculty members particularly enjoy the opportunity to work with the struggling students in a teaching and mentoring capacity. The more challenging task appeared to be teaching several sections of largely dissimilar abilities simultaneously. This was especially challenging since all students, regardless of their ability group level, experienced the identical assessments (exams, homework assignments, and projects) throughout the semester.

Limitations:
While this research has suggested strong evidence for the benefits of an ability-group sectioning policy for the integral calculus course at West Point, such a policy may not be universally beneficial for all academic disciplines or all academic institutions. The small sample size (three year-groups of data) may reduce the significance of some of the statistical results, and the moderate to low R-squarred values suggest that other factors may have contributed to some of the differences in test scores between years.

However, the overall strength of the trends is obvious. Ability-group sectioning was well-supported by both student and faculty opinion surveys, and final exams scores were much higher when cadets were sectioned by ability. At a minimum, this research suggests that further investigation into this topic is warranted.

Relevance Beyond USMA:
This paper has offered both a quantitative and a qualitative assessment of the use of ability-group sectioning in a college calculus curriculum. I acknowledge that many colleges and universities are not inclined to address this issue because it may be seen as irrelevant in a college-setting. However, many colleges and universities are re-emphasizing the importance of teaching and teaching techniques, and many of theses schools are using small classroom settings to encourage student/teacher interaction. An ability-group sectioning policy is ideal in this setting, as demonstrated by the success of the policy in the required integral calculus course at West Point. I would also suggest that many schools may recognize similarities with the West Point system of academics, and that this study may provide evidence for the benefits of ability-group sectioning in other mathematics departments or in a variety of other academic disciplines.

Conclusion:
This research has demonstrated the success of ability-group sectioning in a calculus curriculum at the United States Military Academy. This was evidenced by an obvious, statistically-significant increase in final exam scores. This increase in test scores applied to students of all ability levels, including the students in the "lower" sections. My research also included the (typically overlooked) student perspectives on ability-grouping, and found that an overwhelming majority of students favored the policy regardless of their ability-group level. Finally, this research considered faculty input and found that more than 70% of the total faculty (and 100 percent of the senior faculty) supported the use of ability-group sectioning in the calculus curriculum. Most importantly, this research challenges the commonly-held opinion that ability-group sectioning benefits the top few at the expense of the many at the bottom. In contrast, the students in the "lower" sections experienced dramatic improvements in final exam scores as compared to previous years that did not use an ability-group sectioning policy, and student comments from "lower" sections were immensely supportive of the policy. I will readily acknowledge that the West Point academic experience is somewhat unique when compared to other colleges and universities. However, the significant success of ability-group sectioning in the calculus curriculum at West Point provides strong evidence to continue the policy for the integral calculus course at USMA and to consider (or reconsider) a similar policy in other academic departments or at other academic institutions.

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Acknowledgements:

This work was conducted in collaboration with the United States Military Academy (USMA) Master Teacher Program, offered through the USMA Center for Teaching Excellence (CTE), West Point, New York.

I also thank COL Gary Tidwell, D/Law, USMA [15] for his assistance with the literature review portion of this research.