AC 2008-1124: UTILIZING THE BEST PRACTICES OF THE EXCEED TEACHING METHODOLOGY IN A BIOENGINEERING CURRICULUM.

Chris Geiger, Florida Gulf Coast University

R. Christopher Geiger is an Assistant Professor in the Department of Bioengineering in the U.A. Whitaker School of Engineering at Florida Gulf Coast University. He received his M.S and Ph.D. degrees in Biomedical Engineering from Northwestern University in 1999 and 2003, respectively, and his B.S. in Chemical Engineering from Northwestern University in 1996.

Robert O'Neill, Florida Gulf Coast University

Robert J. O'Neill is Professor and Chair of the Department of Environmental and Civil Engineering in the U.A. Whitaker School of Engineering at Florida Gulf Coast University. He received his Ph.D. in Structural Engineering from Kansas State University in 1993, M.S. degrees in Structural and Geotechnical Engineering from Stanford University in 1984, and a Bachelor of Science from the United States Military Academy at West Point in 1975. He served in the Army Corps of Engineers for 23 years and retired as a Lieutenant Colonel. Dr. O'Neill has been active as a Senior Mentor and instructor in Project ExCEEd for the American Society for Civil Engineering.

Utilizing the Best Practices of the ExCEEd Teaching Methodology in a Bioengineering Curriculum

Abstract

The ExCEEd (Excellence in Civil Engineering Education) teaching workshops are an annual week long workshop sponsored by the American Society of Civil Engineers (ASCE) to help professors throughout civil engineering down the path to becoming "Complete Exemplars" in Joseph Lowman's 2-D model of exemplary teaching [Joseph Lowman, 1995, *Mastering the Techniques of Teaching*, *2nd Edition*, San Francisco, Jossey-Bass]; in other words developing teachers who develop high intellectual excitement in their classrooms while maintaining excellent interpersonal rapport with the students. The workshop focuses on developing skills and techniques that the participants are encouraged to practice during the course of the workshop, then try to implement these skills in their own classes at their home institutions. To date, over 400 faculty members have attended an ExCEEd teaching workshop, and most participants will agree that these workshops have helped them become better teachers. Although it is sponsored by ASCE, and presented as "excellence in civil engineering education", the techniques and principles presented by the ExCEEd program are universal to best practices of teaching, regardless of the subject matter being presented. In this paper, we will present several of the best practices from the ExCEEd teaching methodology and show how they've been integrated into a junior-level biomaterials class offered for the first time at Florida Gulf Coast University (FGCU). Since our students have been exposed to this methodology previously in core engineering curriculum courses at FGCU (both Engineering Mechanics and Mechanics of Materials), the techniques and practices we've integrated into the biomaterials course are not new to them; nonetheless we'll also share the student's assessment into how successful the ExCEEd methodology is in helping them learn.

I. Introduction

The ExCEEd (Excellence in Civil Engineering Education) teaching workshop (ETW) is an annual week long workshop sponsored by the American Society of Civil Engineers (ASCE) to guide professors throughout civil engineering down the path to becoming "Complete Exemplars"[1]; that is becoming teachers who develop high intellectual excitement in their classrooms while maintaining excellent interpersonal rapport with their students. The workshop focuses on developing skills and techniques that will enable participants to become more effective instructors; the participants are encouraged to practice these techniques during the workshop, and then implement these newly learned skills in their own classes at their home institutions. Funding for this program stems from the fact that a major concern in 86% of engineering students is poor teaching in engineering classes[2]. ETW grew out of an NSF funded project in the late 1990s called T^4E (Teaching Teachers to Teach Engineering), which evolved from a six week summer workshop instituted by the United States Military Academy Department of Civil and Mechanical Engineering to train its rotating military faculty and ensure consistent content coverage from year to year.

The "ExCEEd Method" stresses that lessons should have a highly structured organization based on learning objectives and they should appeal to different learning styles. During the course, attendees are shown and allowed to practice ways to develop engaging presentations, including clear written and verbal communication, ways to achieve a high degree of contact with students, the use of physical models and demonstrations, and how to demonstrate enthusiasm for the subjects taught. It also stresses developing a positive rapport with your students, and to make sure that you are frequently assessing student learning and making appropriate use of technology. While most of these concepts may seem obvious in becoming "Complete Exemplars", this list alone may leave many wondering how they can implement these ideals in their classroom. The purpose of this paper is to introduce how the primary author, a Bioengineer, took his week long training and applied it to developing the junior level "Introduction to Biomaterials" and "Biofluid Mechanics" courses at Florida Gulf Coast University (FGCU).

The U.A. Whitaker School of Engineering (WSOE) was established at FGCU in 2004 and classes began in the fall of 2005, with degrees offered in Civil, Environmental and Bioengineering. The mission of the WSOE is to be "Internationally recognized for excellence in interdisciplinary engineering education" and to incorporate innovative, interdisciplinary methods in our engineering classes. In addition to being as interdisciplinary as possible, our classes themselves are unique in that they are almost all taught in an integrated lecture / lab environment, meaning that our three credit hour courses meet for 2 hours twice per week. This extended contact time affords us the opportunity to offer unique opportunities in curriculum development that may not be possible in a traditional lecture setting, however, the methods listed here have been applied at some level to multiple classroom settings, including a traditional large lecture environment.

As one may recognize from the characterization of the "ExCEEd Method", the tools and techniques described throughout the workshop are not techniques specific to Civil Engineering, but in fact are tools that can be used in any educational situation, engineering or otherwise. The real question is how can one take these concepts and adapt or change their current styles such

that their courses end up more dynamic and engaging for the students? By no means does this mean trading style for substance, or making the course any easier. Instead, it suggests taking a close look at one's teaching style, and making small changes that can make a difference in how content is delivered to the students.

II. Adopting the "ExCEEd Method" in Bioengineering

To explicitly demonstrate how the ExCEEd methodology can be used in a Bioengineering curriculum is not a large leap of faith; as was stated earlier the methodology is not rooted in how to become a better Civil Engineering educator, instead its really is focused on how to become a better educator. It just so happens that ExCEEd is tailored to Civil Engineering education. In fact the author was the first Bioengineer to complete the ETW. However, the fact that such a program exists to help Civil Engineering faculty members become better instructors speaks volumes of the American Society of Civil Engineers' commitment to develop new, strong instructors in the Civil Engineering discipline. To our knowledge, this is the only workshop of its type sponsored by a professional engineering society.

Dr. Geiger was fortunate enough to attend an ETW prior to developing and delivering his introductory Biomaterials and Biofluids classes. Having worked with Dr. O'Neill, an ExCEEd master teacher and mentor, the previous spring in co-teaching general engineering courses in Engineering Mechanics (statics and dynamics) and Mechanics of Materials, he was aware of some of the ExCEEd practices but had not fully immersed himself into the ExCEEd method. The knowledge gained through both the workshop as well as working closely with someone who takes to heart the ExCEEd method and philosophy has enabled him to utilize many of the ExCEEd tools and apply them directly to the development of his courses within the Bioengineering curriculum. It is recognized that many individuals may have already spent significant amounts of time developing their courses, therefore in addition to describing what was done to develop the course using the ExCEEd method, the authors will also describe scenarios as to how one may be able to adopt aspects of the ExCEEd method and apply them in their own classrooms. By no means are we suggesting this is the only way to teach, nor are we saying that this is the best way to teach. Our hope is for educators to reevaluate their teaching methodologies and determine what is best not only for them to be effective communicators to their students, but also allow their students to become effective learners.

IIIa. Developing a Structured Organization – Lesson Objectives

The first key to the ExCEEd method is to develop a coherent structured organization not only for each lesson, but also for the class as a whole. The key to developing this organization is defining 2-4 learning objectives for that particular lesson. This can be one of the hardest things to do, however, once these objectives are written down, they are invaluable in developing the lesson in question. The objectives should be classified based on Bloom's Taxonomy[3], and should demonstrate not only what will be taught in the class for that particular lesson, but also what students will learn by the end of the lesson. These objectives should cover multiple levels of Bloom's Taxonomy, from remembering and comprehension through synthesis and evaluation. For the instructor, these objectives demonstrate important areas of coverage that can easily be used for student assessment and evaluation. For the students, presenting them with a list of

lesson objectives prior to the class period offers them insight into not only what will be covered in the upcoming class, but also at what level the instructor expects them to perform at. If the students recognize that the instructor is asking them to "design" or "justify" or "verify" something as opposed to "explain" or "list" or "paraphrase", they recognize that the instructor expects a higher level of comprehension above and beyond rote memorization. Furthermore, if the instructor supports his or her expectations by developing activities and strategies that encourage these higher levels of objectives, the student's will recognize that they must also operate at a higher level.

IIIa. Lesson Objective Implementation

As an example of how lesson objectives can be worked into anyone's classroom repertoire, in the Biomaterials class offered at FGCU, lesson outlines and pertinent readings are distributed to the students prior to their class period. With these readings, students can read the text that complements the lesson for the upcoming day. Instead of just stating the topic(s) that will be covered in that day's readings and lesson, by adding lesson objectives the students gain insight above and beyond the topic to be covered. As a primary example, consider one of the lessons in the Biomaterials course that focuses on corrosion. Instead of telling the students that today's lesson will cover concepts simply related to corrosion, and that they should study the assigned reading prior to the lesson, the following lesson objectives are also listed:

a. Explain the thermodynamic reason for corrosion and develop the Nernst Equation.
b. Analyze Evans plots and polarization curves to better understand corrosion rates.
c. Discuss the various types of corrosion, and understand the differences between them.

Hopefully it is obvious how including these objectives helps define not only what the class will cover, but also helps the students understand what the instructor's level of expectation is. In addition, lesson objectives also offer the students an excellent guide as to what types of questions might be asked on examinations. Instead of having students ask what types of questions they might expect on a given test, if lesson objectives are well thought out, one can simply state that if the students are able to accomplish the lesson objectives, they should perform well on their examinations.

IIIb. Developing a Structured Organization – Appeal to Different Learning Styles

Another key in developing a structured organization is making sure that the presentation appeals to a variety of learning styles. Using the Felder-Silverman model of learning styles[4], one can be grouped based on their preferred input (visual versus verbal), perception (sensory versus intuitive), organization (inductive versus deductive), processing (active versus reflective) and understanding (sequential versus global) style. Although it has been suggested that in general, most engineering students are visual, sensing, active, sequential learners[5] while most teaching is verbal, intuitive, sequential and deductive[6], thus creating a learning / teaching mismatch, it is our experience that for the most part, all types of learners will be present in most engineering classes. We have used the online questionnaire developed by Solomon and Felder (http://www.engr.ncsu.edu/learningstyles/ilsweb.html) in several engineering classes to determine not only how we might be able to better serve our students throughout the instruction

of the course, but also to get the students to recognize how they best learn and to demonstrate why they might do better in a class that offers a lot of visual stimulation versus one whose main method of dissemination is verbal in nature. To give you an example of the wide range of students we typically come across, Figure 1 demonstrates that for this particular class (a freshman level introductory engineering course), although on average the students only show a slight bias for visual learning, there was at least one individual in each category that had a strong bias for each type of learning style.

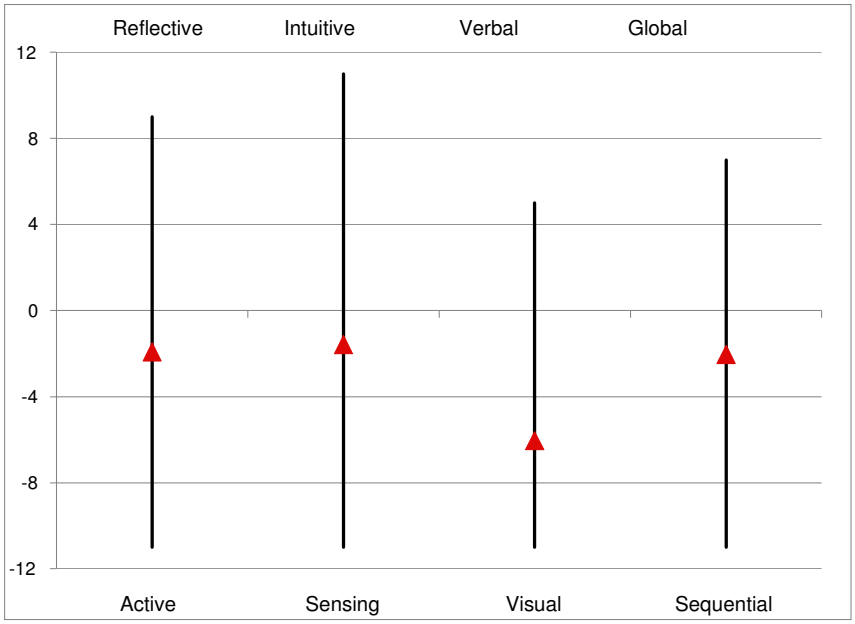

Figure 1: Learning styles results for a group of students in 1006L: Introduction to the Engineering Profession. Scores are out of 11 points, with absolute scores ranging from 1-3 demonstrating balance between the two traits, scores from 5-7 demonstrating a slight bias toward one of the two learning styles (Active vs. Reflective, Sensing vs. Intuitive, Visual vs. Verbal and Sequential vs. Global), and a score of 9-11 demonstrates a strong preference of one learning style over the other. The lines indicate the span of scores for the class, with the red triangles representing the average for the class. N = 85.

One of the more surprising results from the ETW training was the learning style assessment of the program participants. One might think that in a group of similarly trained individuals, who have had a number of years of experience on both sides of the classroom, that their scores might demonstrate a narrower range of variation, and that perhaps their learning styles may be even more balanced than a younger group of students. This could not be any further from the truth. In the end, the faculty members participating in the workshop demonstrated a range that was as large, if not larger than the range demonstrated in Figure 1. Ultimately these exercises demonstrate quite well that there will be a large range of learning styles present in the engineering classroom, and to effectively engage one's students, one must attempt to address all these styles throughout the entire course.

IIIb. Learning Style Implementation

In the Biofluids course offered at FGCU, a number of methods are used in an effort to engage multiple learning styles. For example, when appropriate, video clips have been incorporated into the lessons, and demonstrations to reinforce principles such as non-Newtonian fluid characteristics or the concept of a vacuum. Diagrams are regularly sketched and images projected that are not only pertinent to solving a particular problem at hand but that also demonstrate how a principle may apply to the real world. For example, when explaining the concept of pressure head, in addition to solving problems related to manometry both as a class and within small groups, the class discussed how manometry is used in measuring blood pressure. One could actually take this one step further and bring a blood pressure cuff into the classroom to demonstrate its principles to the students.

In addition to developing presentations containing multiple types of media, because our students all go through the same sequence of courses in mechanics and transport, an effort is made to connect new material to not only where they've been, but also where they are going in the future, so as to present the students with a bigger picture of their educational experience. For example, in Biofluids, we will explain to the students that fluid statics draws numerous parallels to two previous courses they have taken on general engineering mechanics. Furthermore, in Biomaterials, to facilitate various learning styles, the students become the teachers near the end of the semester, and develop presentations that encompass a variety of different biomaterials applications. In addition to developing a presentation and writing a final paper, the students are responsible for developing homework and test questions for the rest of the class based on their findings. All of these examples touch upon various aspects of different learning styles, and as a whole, can allow someone to begin to teach to all types of learning styles.

IVa. Engaging Presentation – Clear Written and Verbal Communication

One of the "trademarks" of the "ExCEEd method", and one of the concepts that is stressed during the workshop is how material is presented to the students. Although this subject will also be addressed in a slightly different context in Section V, the program mentors strongly encourage the use of whiteboards (blackboards) as the primary tool for conveying information to the student. While we will comment on the rational for doing so in Section V, it is pertinent that in order to use this type of technology, the instructor must have a clear idea as to not only what they want to write, but how they want to write it. Information on these boards must be written not only so that it can be read easily (i.e. write legibly and large with consistent format and case), but also that it is grouped together in a logical fashion and hierarchy. Furthermore, one cannot spend their time writing lengthy definitions or information that is ultimately unimportant.

In addition to presenting written information in a clear, concise fashion, the instructor's verbal communication skills must also aid in engaging the student. This means making sure to practice proper articulation and effective voice projection, especially when the instructor's back is turned toward his or her audience while writing on the board. Beyond these basics, varying the voice volume, speed, pitch, tone and intonation can definitely help animate an instructor's message, and interjecting a certain level of enthusiasm into the lesson will certainly catch the attention of

his or her students. After all, how can an instructor expect his or her students to get excited to learn about a subject they don't sound excited to teach?[7]

IVa. Communication Implementation

Obviously the implementation of verbal communication is an individualistic preference. The authors have a tendency to attempt to engage students not only through vocal inflection, but also through non-verbal communication such as making eye contact with numerous students throughout the room, and walking throughout the room during the course of a lesson as opposed to standing behind a podium or directly in front of the whiteboard for the entire lesson. Once you make sure you are projecting your voice such that the entire classroom can hear you, implementing vocal inflections makes a large difference in keeping the attention of your audience.

To make sure your written communication is clear and concise, especially when writing information onto the whiteboard, the only way you can make sure your boards look good is to practice. This means not only practicing *how* you write, or writing information on the board and going to the back of the classroom where some of your students may be sitting and making sure your writing is still legible at that distance; but it also means that you need to practice *what* you write. In the authors' case, that is accomplished through the development of board notes. The ETW stresses the importance of board notes, not only from the standpoint of preparing for a lesson, but also using them as a reference during the lesson, and then keeping them as a record of what was taught during the lesson. Board notes contain all the lesson content you intend to cover in class, and can include such things as visual aids and demonstrations, questions that you might want to ask your students, or transitions between topics. Figure 2 is an example of two panels from a Biofluid mechanics lesson on hydrostatic pressure.

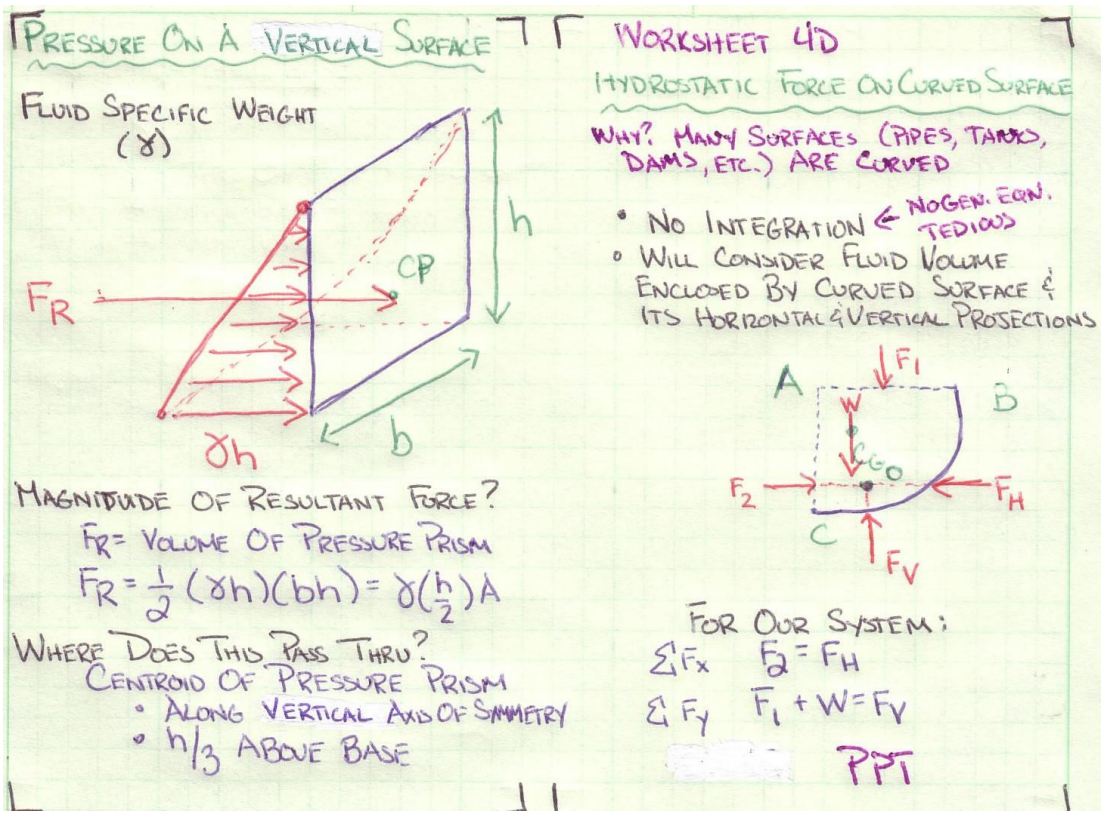

Figure 2: Board note panels from a Biofluid Mechanics lesson on hydrostatic pressures.

There are several key qualities to this type of board layout that we would like to highlight. First and foremost is the consistent use of multiple colors throughout these board notes (which subsequently translates to the consistent use of multiple colors on the lesson boards in the classroom). The ETW stresses the use of multiple colors of markers (chalk) to illustrate a hierarchy of ideas, add visual "life" to materials and enhance the clarity of drawings. In the scheme shown above, green is used for section headers and coordinate systems and lengths in figures and drawings, black is used as the primary points within a given section, blue is used for secondary points, equations and drawings, and red is used for forces acting on bodies. The purple color are notes for the instructor with regards to questions he may ask the class, or reminding him to go over to the PowerPoint presentation he is also using to continue the discussion with the class. Each panel represents approximately 2 feet of horizontal space on a whiteboard covering the entire height of that board. The other quality that one sees is how different ideas are separated. Each section starts with an underlined section heading to let the students know that a new section or topic has been started. The notes use consistent spacing in regards to indentations and bullet points, so that it is obvious where idea groupings are located. Although not shown here, key equations or points could be underlined or boxed in a different color to make them stand out from the rest of the board.

Of the concepts introduced in this paper, this type of preparation is what we feel has the biggest impact on developing an engaging, clear and concise lesson. Unfortunately, it is also one of the hardest techniques to integrate into a course that has already been planned. What can be done, however, is to take the principles (color, grouping and spacing of ideas, boxes, underlining, etc.) and determine how these may be implemented gradually throughout the course. If a new module

or lesson is added, perhaps try using some of these methods and see if it adds clarity to the lesson. Even PowerPoint presentations can benefit from the implementation of these principles.

IVb. Engaging Presentation – High Degree of Contact with Students

Beyond both verbal and written clarity, a successful, engaging presentation often requires that the participants play an active role during the presentation. Having a high degree of contact with the students plays an important role in developing an engaging lesson. Lessons should encourage multiple levels of contact, including such things as classroom discussions; questions (both from the instructor as well as from the students); and active learning in small groups, including in-class exercises such as problem-solving, laboratories, small group discussions, etc. Interacting with students at these different levels (one-on-one, small group, classroom) offers the instructor the opportunity to not only develop a positive rapport with his or her students, but also the ability to present the lesson material in a variety of environments, allowing the student multiple opportunities to absorb the information.

One of the easiest ways to develop higher degrees of contact with students is to ask them questions during the lesson. Questions can be used to refresh prior knowledge, connect this prior knowledge to a new topic, stimulate critical thinking about a topic as well as to develop methodology and solutions during in class problem-solving exercises. The ETW offers a variety of methods that can be used to ask questions and demonstrates how to use them through master classes taught by several of the mentors throughout the week. During these one hour classes, as many as 40 – 50 questions might be asked, and the master instructors make sure that everyone in the room is asked a question. A variety of questioning techniques are used, ranging from jump ball type questions that are open for anyone to answer, to questions that target specific people in the class to questions that ask for the involvement of the entire class. The key to using this type of technique is knowing one's students; not only their names, but also their personalities. Some students might feel intimidated when put on the spot, so the way in which one phrases a question, and how long one waits for a response is critical to developing these techniques. It also requires careful listening to a student's answers, making sure that when one says their answer is "correct", it truly is correct. Furthermore, if their answer isn't exactly what the instructor was expecting, he or she needs to try and separate out the parts that are right from the parts that are not.

In addition to questioning, active learning is another way to develop a high degree of contact with students. Due to the length of classes at FGCU, if the class were solely developed having a lecture format, the students would quickly tune out the instructor, as it has been shown that even for the most entertaining of professors, most students only pay attention in 15 minute intervals[8]. What this means is that the "breaks" in a lesson should consist of activities that not only allow the students time to refocus, but continue to be involved in a learning environment. At FGCU, these breaks often consist of classroom demonstrations, laboratories, or problem-solving exercises in small groups. In particular, allowing the students to work in small groups during laboratory exercises or problem-solving exercises allows for a high degree of student contact during the lesson. The student-instructor dynamic in these smaller groups can be much more intimate than in a classroom setting, and as such instruction can be tailored to suit the individual group's needs, which may be different than those of the class as a whole.

IVb. Student Contact Implementation

During any given lecture, numerous questions will be asked regarding the relationship between old topics covered and new topics being introduced, help in developing lists and examples of real-world phenomena related to the topic at hand, as well as developing problem-solving methodologies. As an example, one topic covered in fluid statics is the determination of a center of pressure for the resultant force of a column of water acting on a submerged surface. Using a variety of questioning techniques, we were able to demonstrate to the class the mathematical correlation between how to determine the center of pressure in fluid mechanics and the development of the elastic flexure formulas presented in Mechanics of Materials for a beam undergoing pure bending which the students took the previous year. In developing some of these equations, we stress the correlations between fluid and solid mechanics, and ask the students to help set up the problems, keeping these correlations in mind.

The students are also asked to break into small groups throughout the lesson for problem-solving and/or laboratory exercises. In a given class, 3-5 group exercises may be planned for a given 2 hour lesson. These exercises supplement and reinforce the class lesson, and allow the students to not only help each other solve the problem at hand (students teaching students), but also allow the instructor to interact with the students in a small-group setting. As an example, in fluid mechanics, for a lesson on fluid statics, we will determine the equations for different types of manometers as a class, however, we will break up into small groups to solve problems based on manometry. After working in small groups, the class will reconvene and discuss the solution as an entire class. This system allows one not only to break up the class into small enough sections of time to prevent tuning-out[8], but also allows the instructor extra opportunities during the class time to assess each individual's understanding of the lesson material.

V. Appropriate Use of Technology

One debate that seems to appear time and time again at ASEE is how to use (or even should one use) PowerPoint in the classroom. It is our opinion[9], and is stressed throughout the ETW, that there are appropriate uses for many types of technology, both high-tech (PowerPoint, other computer applications, modeling software, Podcasts and Webcasts, etc.) and low-tech (whiteboards, overhead transparencies, ELMO Visual Presenters, physical models, etc.). The key to using these technologies is to understand each technology's strengths and weaknesses and subsequently use that particular technology to the best of its capabilities. The focus of any technology should be on how the tool aids in student learning, not how it aids the faculty member in content coverage.

In a recent survey conducted in the Biofluid Mechanics class, the entire class emphasized that they preferred the use of white boards for lesson presentations. They stated that using the techniques previously mentioned, presentations using whiteboards were well organized, both in how the material was presented as well as how the actual notes were arranged, making the class easier to follow and making their notes more useful when it came to studying. Their main complaint regarding the use of PowerPoint was that pacing was an issue; too much information was being presented in too short of a period of time. In talking with other faculty members at

other institutions, these comments are not unique to students at FGCU; similar complaints have been heard nationwide. The real question is how to balance high-tech and low-tech; how does one use multiple types of technology effectively and seamlessly in the classroom setting? Although the answer to this depends on a number of factors, including the instructor's teaching style, the content of the class being taught (mathematically based content versus text driven learning), and the limitations of the classroom within which the class is being taught (computers in the classroom, amount of whiteboard space, etc.), there are certainly a few things to keep in mind.

In Wankat and Oreovicz's book *Teaching Engineering*, they state that the most important prop in the classroom is the whiteboard. However, they warn that this medium is not the best way to present large quantities of detailed information[7]. Although this book was written prior to the mass introduction of computers into the classroom, it is stressed through the ETW that this statement still holds true today. Whiteboards are effective because they are self-pacing; one can only cover as much material as he or she can write down, hence the pace ends up being better aligned with the student's capacity to take careful notes. Furthermore, whiteboards allow information to remain visible so that one can easily come back to an important point later in the lesson. The use of whiteboards also allows flexibility, promoting spontaneity and non-linearity not only from the instructor, but also in promoting engagement from the student, as questions can be posed requiring student participation, and questions from students can easily be answered and potentially incorporated into the lesson.

However, whiteboards are not the be all end all for technology in the classroom. Transcribing large tables, providing large amounts of verbal information or writing lengthy, detailed derivations where errors can be made either by the instructor, or transcribed incorrectly by the student are all areas where other technologies can be effectively used. In these cases PowerPoint has a place in the classroom. One can think of PowerPoint as a "transparency on steroids", capable of doing so much more than a standard transparency; including the ability to incorporate digital images, movies and other multimedia technologies, and allowing dynamic delivery of material through the use of builds and transitions. Although these strengths, when effectively used, offer a significantly enhanced learning environment, the overall linearity of a PowerPoint presentation, the potential for pacing problems, and the time required to effectively create a learning-centered presentation temper some of these advantages. Furthermore, during most presentations, the student's role is changed from an active to passive participant. Coupling this with the fact that PowerPoint presentations often require the lights in the classroom to be turned off or dimmed can cause attention issues.

V. Technology Use Implementation

In asking what type of presentation methodology the Biofluid Mechanics students preferred, one student wrote that it depended on the type of class. For math based classes, he preferred content delivered via whiteboard, while for classes whose content was oriented more toward text based content or classes that were project oriented he preferred content delivered via PowerPoint. This is a great example of how different types of classes require different types of presentation styles. In the Biomaterials class, approximately 60% of the classroom content was delivered through the use of computer based technology, primarily movies and PowerPoint presentations. As shown in

Figure 3, these presentations were made as stimulating as possible through the use of transitions and builds, allowing the instructor the opportunity to comment on specific regions of the slide, and allowing the students to concentrate on a particular portion of the slide as opposed to trying to take the entire slide in all at once. Furthermore, the use of builds or transitions allows the instructor the opportunity to ask the students questions to ensure that they understand the concepts being presented.

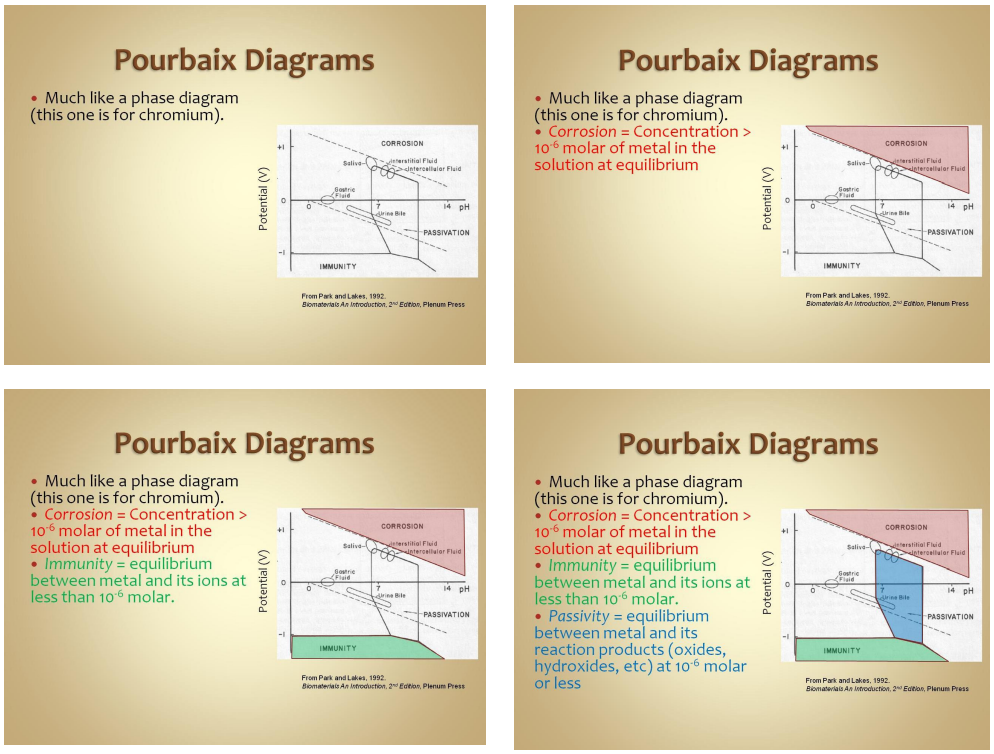

Figure 3: The use of transitions in a PowerPoint presentation

The remaining 40% of the content was delivered primarily through whiteboard notes (30-35%), movies and other computer-based technologies, and in-class demonstrations and physical models.

One thing that was not done in the Biomaterials course this year that will be implemented next year is the use of "skeleton notes" for PowerPoint presentations. Instead of giving students the entire presentation prior to the class so that they have the information in front of them during the lesson, the "skeleton notes" will have information missing from the PowerPoint presentation, requiring the students to "fill in the blanks" as the lesson progresses. This type of method requires the students become a more active participant during the lesson. Another possible way to keep the students active during the lesson is to couple the use of PowerPoint with the writing capabilities of Tablet PCs. This would allow for more student interaction during the course of the lesson, and would allow for more flexibility when developing PowerPoint lessons. This type of technology has not seen widespread implementation at FGCU, however, professors at other institutions have used it with success in their classrooms.

In comparison to the Biomaterials class, the Biofluid Mechanics course has approximately 80% of its content delivered through whiteboards. As shown in Figure 2, the whiteboard offers a lot of flexibility when it comes to solving problems, or understanding how problems are set up. The remaining content includes PowerPoint deliveries, used primarily to present images, complex diagrams and large tables (approximately 10%); movies of demonstrations and phenomena seen in nature that relate to the topic being covered; computer based simulations of flow phenomena; web content (Flash animation, websites, etc.); and real-world demonstrations and physical models.

VI. Conclusions and Acknowledgements

It was our intent through the development of this paper to offer ideas and suggestions on how teaching techniques can be modified to better engage the student and provide an environment that results in more effective learning for the student. Techniques such as the development of lesson objectives and working toward engaging the students and teaching to multiple learning styles can be implemented without significant alterations in current lesson plans. Other techniques, such as the development of board notes and the appropriate use of technology may be more difficult to immediately implement. We hope that through the concrete examples provided, we have laid the groundwork for instructors who are interested in changing their teaching styles such that they can use these suggestions as a template to implement a change. For those instructors who are already effective teachers, we hope our ideas reinforce the reasons that you are a good teacher. We do not claim that this is the only way to effectively teach nor do we claim that this is the best way to teach, however, it is a method that is time-tested and helps make teaching an enjoyable endeavor for us.

We would also like to point out that this is a significantly abbreviated version of the "ExCEEd method" presented in the ETW. It only begins to scratch the surface of what is taught in the ETW and subsequently what has been implemented into the aforementioned Bioengineering courses taught at FGCU. The authors would like to thank ASCE, and everyone involved with the ExCEEd teaching workshops.

Bibliography

1. Lowman, J., 1995. *Mastering the Techniques of Teaching*, *2nd Edition*. Jossey-Bass.
2. Seymour, E. and Hewitt, N.M., 1997. *Talking About Leaving: Why Undergraduates Leave the Sciences.* Westview Press.
3. Anderson, L.W. *et. al*, 2001. *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxononomy of Educational Objectives.* Addison Wesley Longman, Inc.
4. Felder, R., 1996. "Matters of Style." *ASEE Prism*, 6(4) 18-23.
5. Zyno, M.S., 2003. "A Contribution to validation of score meaning for Felder-Soloman's Index of Learning Styles." *ASE Conference Proceedings*, Session 2351.
6. Felder, R. and Silverman, L., 1988. "Learning and teaching styles in engineering education." *Engineering Education*, 78(7), 674-81.
7. Wankat, P.C. and Oreovicz, F.S., 1993. *Teaching Engineering*. McGraw-Hill, Inc.
8. Wankat, P.C. and Oreovicz, F.S., 2003. "Breaking the 15-Minute Barrier" *ASEE Prism*. 12(8).
9. O'Neill, R.J. and Ressler, S.J., "The Chalkless Classroom: Yes or No?" *Proceedings of the Fourth Congress on Computing in Civil Engineering*, ASCE, Philadelphia, PA, June 1997.