Teaching Resources for the New Millenium: Statics as an Example

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Abstract

Education research from the late 20th century suggests many benefits of incorporating pedagogical methods like cooperative learning, peer instruction, critical thinking exercises, and classroom assessment. However, developing instructional materials incorporating these methods takes a significant amount of effort. This paper describes an example of developing instructional materials for instruction in engineering mechanics (statics) using collaboration between faculty members at two universities, the National Science Foundation, and a commercial publisher. These resource materials adapt many of the pedagogical components referenced above. Two experienced faculty, while teaching both large and small enrollment classes at two different universities, have developed these materials. The benefits of these materials include encouraging students to take ownership of their learning, helping instructors focus on critical content, and turning classroom lectures into engaging discussions. The materials also cycle through different parts of the Kolb learning model and address different learning styles. Other aspects of these instructional materials promote cooperative learning and classroom assessment tools to provide quick feedback to both students and instructors. The resource materials include animated PowerPoint presentations of the critical content and a bank of quiz questions for each class period. The concepts used for developing teaching resources in this paper can easily be adapted to any other science, math, engineering and technology (SMET) course. A possible funding source for such an effort is NSF's Adapt and Implementation (A&I) track of the Course Curriculum and Laboratory Improvement (CCLI) Program.

Introduction

Education research from the late 20th century suggests many benefits of incorporating pedagogical methods like cooperative learning, peer instruction, critical thinking exercises, and classroom assessment (Angelo & Cross, 1993; Boyer, 1998; Hake, 1998; Johnson et. al, 1998; MacGregor et. al., 2000; Mazur, 1997; McKeachie, 1999; NRC, 2000; NSF, 1996). Patricia Cross, a leading educator, also indicated in her American Association of Higher Education's (AAHE's) 1998 National Conference keynote address that, "We have more information about learning available to us than ever before in the history of the world." Herbert Simon, a Nobel Laureate, in his 1997 Frontiers in Education Conference plenary session said, "Knowledge about human learning processes has developed to the point where we can do better."

Mazur (1997) used diagnostic tests to assess student learning of introductory physics for both experimental (using concept questions and student interaction) and control groups by recording pre- and post-instruction performance. He found significant gains in student learning (as measured by use of established diagnostic tests for physics) as a result of his experimental conditions. In addition to using diagnostic tests, Mazur compared student performance on identical final examinations (given six years apart) for a conventionally taught physics class versus an experimental class. He also found a "marked improvement in the mean, as well as a higher cut-off in the lower-end tail" (p. 16). This improvement of the poor to average student's learning is an important effect.

Hake (1998) analyzed pre- and post-standardized physics exam data for over 6000 students. He found that a percentage gain of physics knowledge was twice as high for students taught with an interactive engagement method as compared to students taught using traditional lecture-based teaching. The National Research Council report (NCR, 2000) indicates, "Sixth graders in a suburban school who were given inquiry-based physics instruction were shown to do better on conceptual physics problems than eleventh and twelfth grade physics students taught by conventional methods in the same school system."

Based on these ideas and additional educational research, a set of core beliefs, named Next Generation (NG) Principles, are posited by the authors. These principles fundamentally believe that active learning by students is vital. However, teaching resource materials that incorporate new paradigm instructional components like active cooperative learning, concept and reading quizzes, classroom assessment, and outcomes-based teaching are typically not available.

Sheila Tobias, in her foreword to Mazur's book (1997), says, "Implementation of pedagogy-based teaching is challenging. Instructors need support and assistance." The situation is made even more difficult by the reality that "specialized" materials using these new paradigms have to be developed for each specific course. Hence, there is an immediate need for pedagogy-based materials that instructors can directly use in their classes without investing too much of their own time in developing them. For developing and distributing such materials, a cooperative model of faculty, granting agencies, and a commercial publisher has been used. The National Science Foundation's Division of Undergraduate Education (DUE) suggests this model in its Educational Material Development (EMD) Track of the Course Curriculum and Laboratory Improvement (CCLI) Program.

This paper describes the results of such an effort, resulting in the development and use of a set of resource materials for statics, a key course in engineering science. Funding from NSF's CCLI program (described above) provided partial support for this development effort. Statics is taken by all engineering majors and is also offered at two-year colleges with pre-engineering programs. A statics course is included in most of the 2285 ABET-accredited_two and four year engineering technology programs. While the total number of students taking statics is hard to estimate, the Engineering Workforce Commission indicates that there were over 90,000 full-time first-year-engineering students in 1997-98. Thus, the number of freshman and sophomores taking statics each year is well over 100,000, when engineering technology programs are taken into account.

The primary objective in developing these materials is to enhance the student's learning and understanding of statics. Teaching methods that incorporate a wide variety of pedagogy help accomplish this objective. Thus, the resource materials have been developed based on educational theories and practices proven to enhance student learning. A second objective in developing these materials is to encourage and enable other teachers to take up the intellectual challenge of using these and other education research-based materials with the thoughtful intent of observing the impact on student learning.

The resource materials are in the form of PowerPoint slides so their usage is both flexible and easy. They can be used with both "high" and "low" technology. Instructors can use the materials following our suggestions as described below or they can use portions of it in ways that best fit the needs of their teaching philosophy and students.

Next Generation Principles

A recent report from the National Research Council (NRC, 2000) describes basic principles having profound implications for teaching and learning. Also, the Education Commission of the States (ECS, 1996) describes twelve attributes of good practice in delivering undergraduate education. Using these and other resources, twelve Next Generation (NG) Principles are suggested. The NG Principles are organized into three groups: overarching, foundational, and advanced (see Figure 1). The overarching group contains basic guiding principles common to all teaching and learning activities. The foundational principles provide a solid backbone to engineering education—principles that without which the advanced principles generally do not succeed. The advanced principals are based on enhanced learning resulting from use of methodologies like active collaborative learning, peer instruction, and service learning. These principles are listed below. A detailed description of these can be found in Mehta & Danielson (2000a).

The fundamental principle underlying all these Next Generation principles is that, as instructors, we care deeply about student learning and believe that we can make a difference in their lives. With this principle in place, instructors can explore different ways to help students reach their highest potential. As new findings come from the frontiers of brain research, cognitive science, genetics engineering, etc., teaching strategies can be reshaped to enhance student learning.

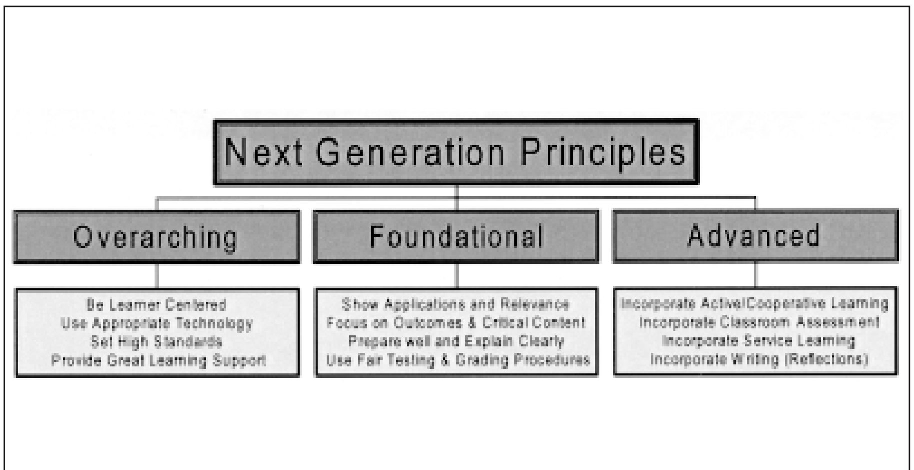

Figure 1. Organization of the Next Generation Principles

NG Teaching Materials

An overview to key aspects of the NG materials and suggestions for using them follow. The resource materials are PowerPoint slides and, hence, are highly flexible. If mediated classrooms are available, the slides can be projected onto a large screen using the computer system. If only an overhead projector is available, the slides may be printed onto transparencies. Instructors can select the slides they think are appropriate for their students or they can easily delete or add slides to their presentation.

These materials are being published by Prentice-Hall and are linked (via the use of pictures and illustrations) to the textbook ***Engineering Mechanics Statics*** by R.C. Hibbeler (2001). Excerpts included here are shown by permission. Similar materials are also being developed for dynamics classes. The following section on lecture notes, student notes and an implementation strategy.

Lecture Notes

Objectives:

The first slide (Figure 2) of each lecture presentation has well defined student learning objectives. This helps students identify clearly what they are expected to know and be able to do after the lecture. They also help the instructor focus the class discussion on the main topics at hand and assessment of whether the students have achieved the objectives.

In-Class Activities:

The first slide of each lecture presentation also lists things to be done during the class period. The lists of objectives and in-class activities give students a clear idea about the overall picture and structure of the lecture (hence satisfying both global and sequential learners). The first slide also has a picture related to the main topic. Hence, the first slide should get attention of both visual and verbal learners.

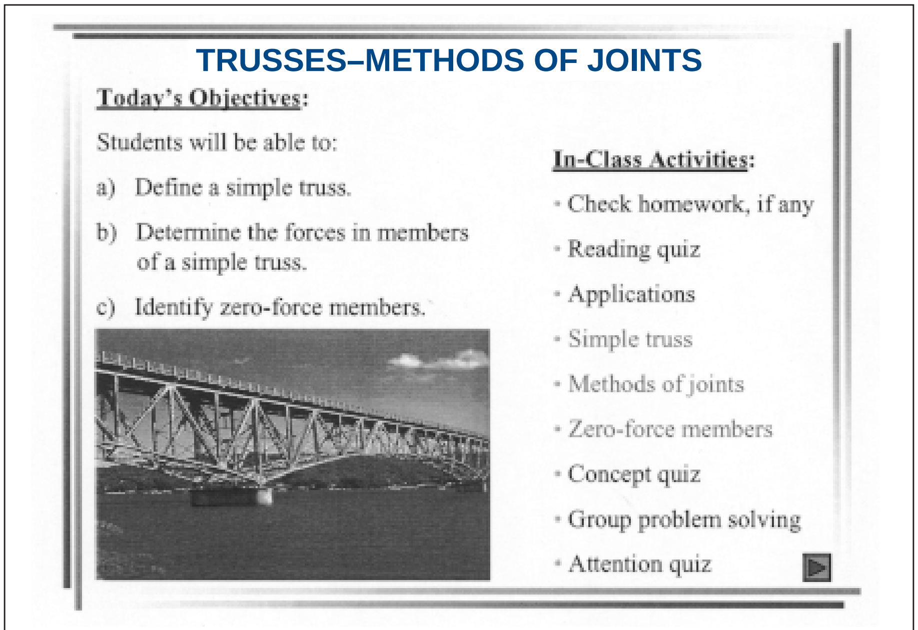

Figure 2. Objectives and In-Class Activities Example

Reading Quiz (RQ):

The second slide of the presentation (Figure 3) is typically a Reading Quiz (Mazur, 1997). It usually consists of two multiple-choice questions based on the reading assignment for that day's class. It is expected that students come to the class prepared by reading the Student Notes (discussed below) and the assigned reading from the textbook. The RQ questions are simple and straightforward, so if students have spent about 20 to 30 minutes going over the material, they should be able to answer the questions correctly. The students use answer sheets to record their homework grades and answers to the quiz questions. These answer sheets are turned in at the end of each class period. They can be machine graded for large classes or quickly hand graded by the instructor when teaching a smaller class.

Typically, doing the reading quiz takes two-three minutes and includes explaining the correct answers before moving on into the rest of the material. This provides immediate feedback to the students about their grasp of the content. While the RQ helps instructors determine how well the students have prepared, more importantly, they provide an incentive for students to come prepared. Coming prepared to the class is an important part of students taking ownership of their learning. This also facilitates useful classroom discussion and spending classroom time on more difficult topics.

Applications:

After the reading quiz, the presentation typically has two slides depicting real-life applications of that day's topic (Figure 4), which stems from NG Principle of showing applications and relevance of the material. These slides have thought-provoking questions to raise student curiosity, incentive, and motivation to learn the material. These questions can also be used for a short group discussion on what students already know about the topic.

Mini-Lecture:

After discussing applications, the relevant theory and concepts are discussed. These materials are based on "critical content" (key points for desired student outcomes and difficult material, as per the NG Principle of focusing on outcomes

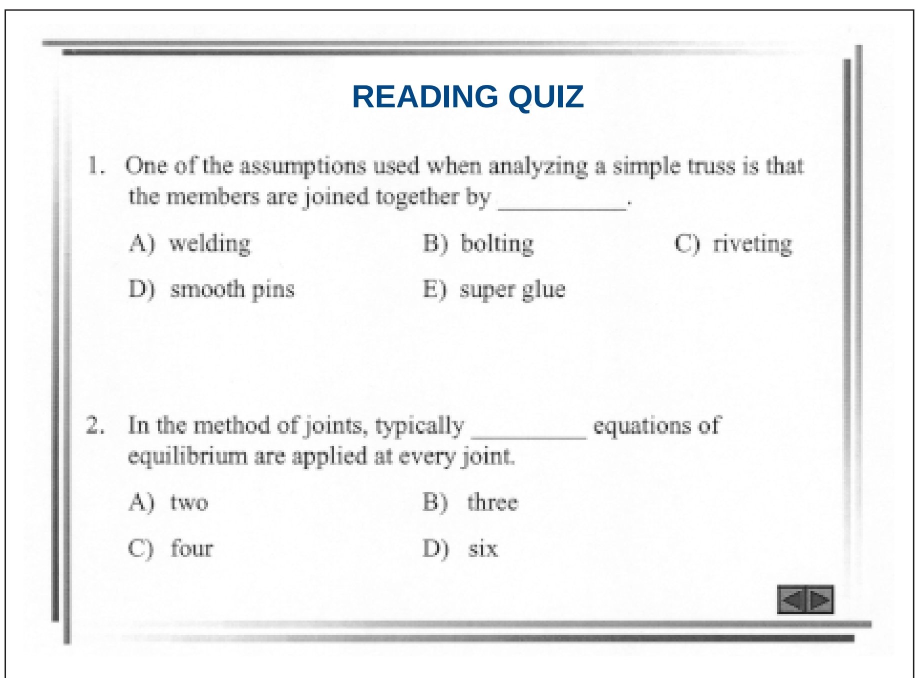

Figure 3. Reading Quiz Example

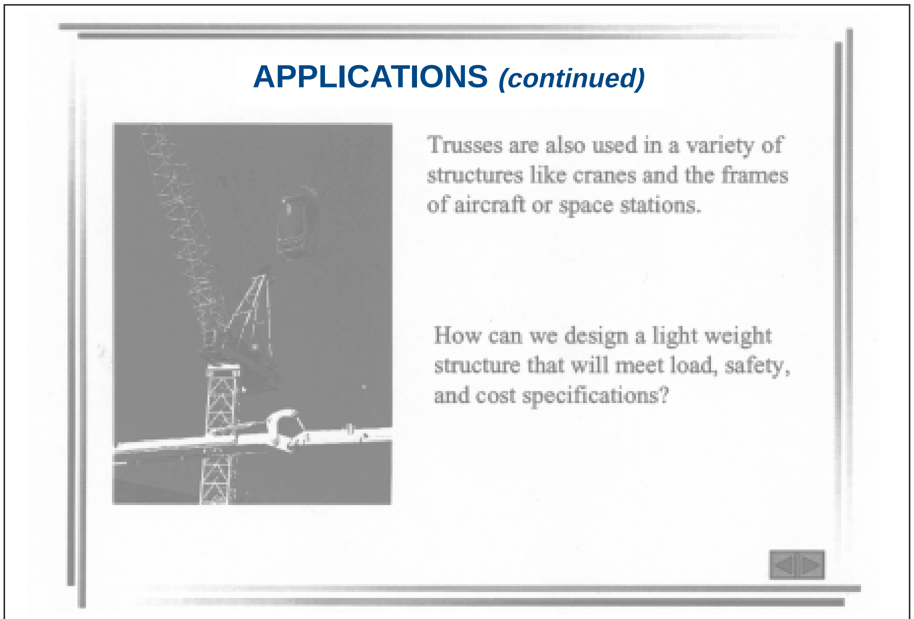

Figure 4. Application Slide Example

and critical content). Typically, every slide (an example is in Figure 5) has a picture related to the words and hence is useful to both the visual and verbal learners. Most of these figures are taken from the textbook and provide a connection back to the book for the students.

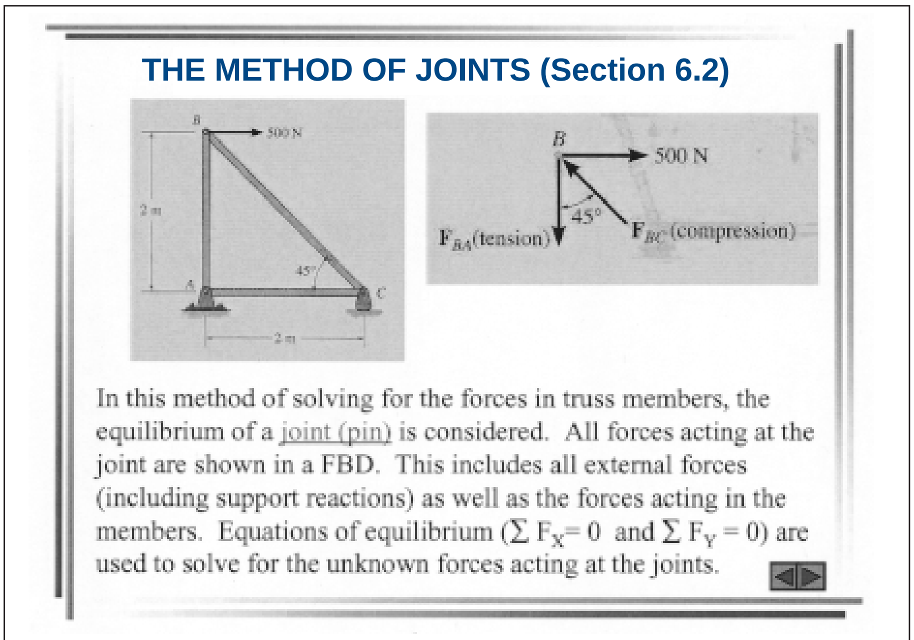

Figure 5. Lecture Slide Example

Example Problem:

The mini-lecture is followed by a typical example showing how the theory or concept just discussed can be applied to solve a problem (Figure 6). These solutions are not exhaustive in detail due to space constraints; however, they immediately reinforce the material for the students.

Concept Quiz (CQ):

Students in science, math, or engineering classes often focus on plugging numbers into equations rather than understanding basic concepts. Mazur's (1997) powerful data provide strong reasons to adopt his methodology of using concept questions and student interaction to provoke students into a more comprehensive understanding and learning. Concept questions attempt to probe into a deeper understanding of a concept, rather than simply plugging numbers into equations. The CQs are usually two multiple-choice questions (Figure 7). Our suggested technique in using them involves peer instruction and cooperative learning. First, students individually record their answers to the questions on their answer sheet. Then at the instructor's signal, students discuss the questions with their neighbors. After discussion, students record a new set of answers (which can either be the same or different from their first set of answers) on the answer sheet. Next, a verbal response from the class is obtained by asking students what they picked as the answer. This verbal response gives the instructor instant feedback about student responses to the quiz. Then, the instructor confirms the correct answer and asks one of the students to explain the answer.

Group Problem Solving:

The CQ is followed by a problem that groups of two or three students are asked to solve (Figure 8). Students do not learn engineering mechanics materials simply by reading or listening to an instructor. They typically learn the material by solving examples. In our experience, it is important that students have an opportunity to solve a problem right away, as soon as a topic has been discussed. This helps to quickly clarify many of the doubts and questions that students typically have when they try to solve the problems on their own at home. A group of student volunteers, as explained later, can assist in this activity in a large class. This problem solving activity allows the instructor to wander the classroom, observing as students struggle with the problem. This assessment situation also provides the instructor a natural opportunity to act as coach to the students in their learning.

Attention Quiz (AQ):

The last event of the class period is another set of two multiple-choice questions based on the day's material (Figure 9). These questions may require simple calculation or may be concept-based. Again, these quiz questions takes two-three minutes and include explaining the correct answers, if time permits. This activity again provides immediate feed-

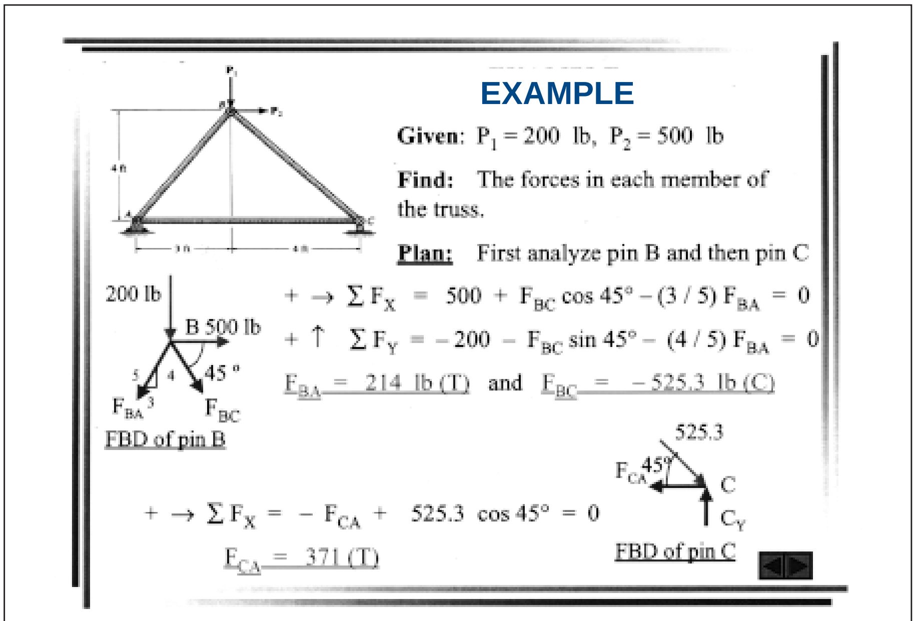

Figure 6. Example Problem Example

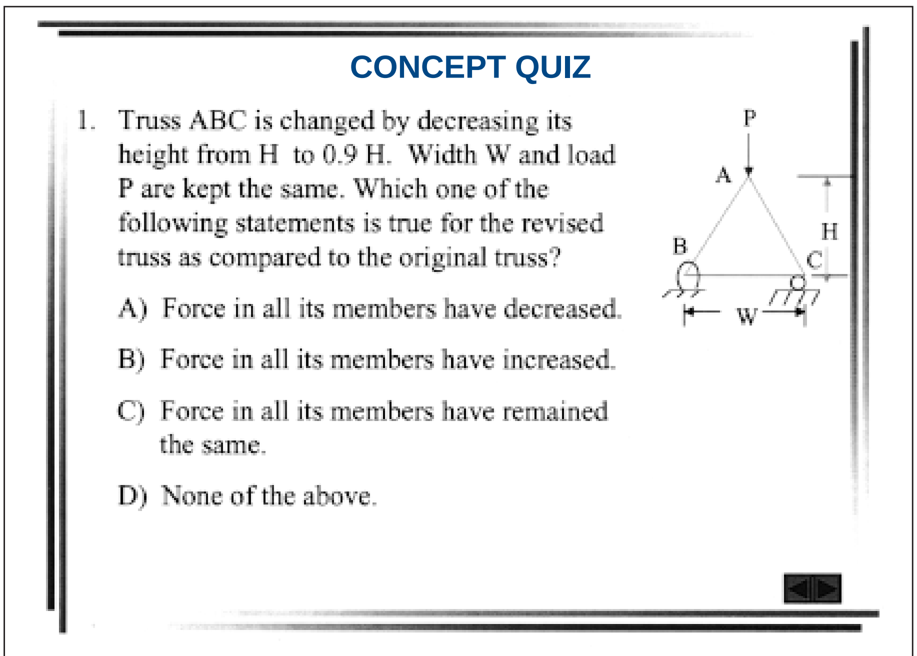

Figure 7. Concept Quiz Example

back to the students about their grasp of the content (Mehta, 1993, Panitz, 1996).

The Kolb Learning Cycle:

Kolb's Learning Style Model (1984) is incorporated into the design of these instructional materials. Kolb suggests that students learn in different ways and we should design the instruction to "give something to everyone." The learning cycle starts with Concrete Experience (real-life applications, in our case). The next part of the material is the mini-lecture, which explains abstract concepts related to the topic. This is followed by Reflective Observation (here student groups discuss what they know about the topic via the concept quizzes). The last part of the cycle is Active Experimentation, where students see how the concepts discussed apply in solving a problem. The processing part (Reflective Observation and Active Experimentation) of the Kolb Model addresses internalizing or transforming the information and is encouraged by the concept quiz and group problem solving experience.

3.2 Student Notes

The Student Notes are altered version of the Lecture Notes and are prepared and given to the students ahead of the class period. This is done for several reasons. First, students should come to class prepared and take ownership of their own learning. Classroom time should be spent in active engagement or discussion of what they already know, real-life applications and relevance, critical content, concept questions, and group problems. Students' time spent blindly copying notes from the board or screen, which according to Morrison (1986), keeps their heads empty but their notebooks full, is minimized.

First, all the quizzes are deleted. In addition, most of the detail from the group problem solution is removed by keeping the important steps with blank spaces for students to fill in the details. Instructors have a choice of using the file with the partial solution slides or they may delete those slides to force the students to solve the problem entirely as a group. If following the second approach, the problem-solving slides are deleted before making the file available to the students. The student note files can be distributed to the students in several different ways, including the world-wide-web. Whatever the delivery method, it is advantageous for the students to have the notes before the day of class so they can use them to prepare.

3.3 An Implementation Strategy

The following describes one method of implementing NG materials in a 50-minute statics class (meeting three times a week). The way instructors design and implement their instruction can be significantly different, depending upon the class time period, types of students, their learning styles, and teaching style. The materials and implementation have also been used extensively in a 75-minute class setting (twice a week). In the 75-minute venue, more time can be given to the homework and example problems than described below.

Typically, the class begins with students grading two to three assigned home-

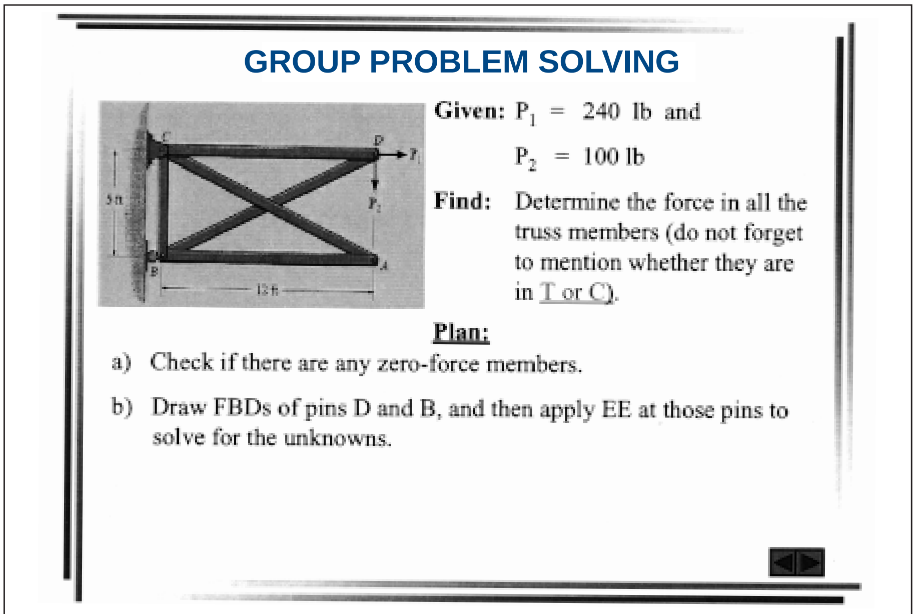

Figure 8. Group Example Problem Example

work problems from the text. The homework is exchanged with a neighboring student and graded in class at the beginning of the class period (Mafi, 1989). The instructor uses an overhead projector or PowerPoint slide to display the solution and discuss it. To prepare the students for the grading, procedures and practice grading is done at the start of the semester. Students can receive either a letter grade (from A to E) for each of their problems or a numerical score, as appropriate for the level of technology used by the instructor.

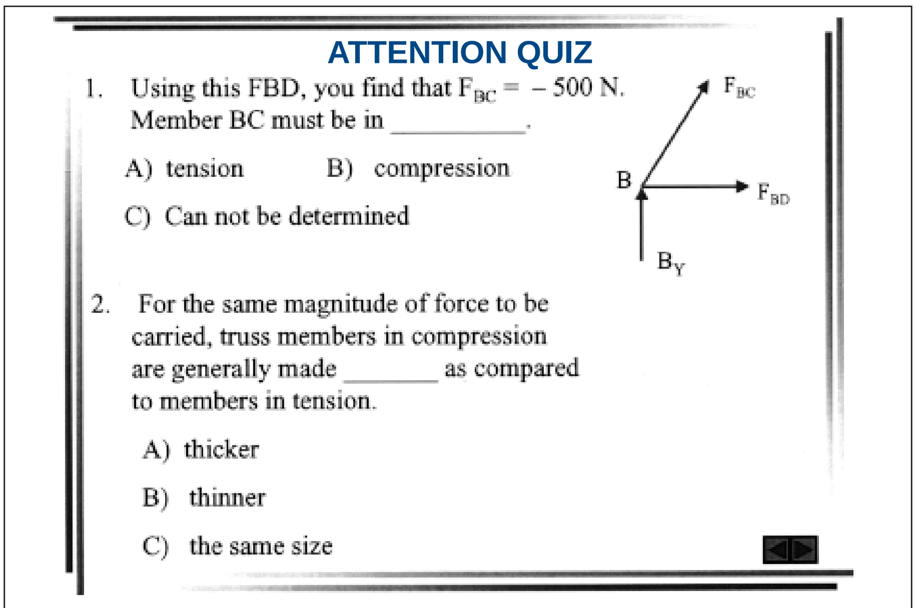

Figure 9. Attention Quiz Example

If the instructor is hand recording grades, the students use a specially prepared grade sheet (Mehta, 1997) to record grades for each day's activities. Or an optical scan sheet (Mehta & Schlecht, 1998) uses an A through E system so results can be scanned and results posted electronically. To minimize the temptation of cheating, students are asked to have homework graded by different graders, with the graders required to sign-off on the corrected homework paper. Also, students can be required to save the homework in their class portfolio notebook for periodic review by the instructor.

If used, the student's class portfolio contains their homework, quizzes, and tests. Students can also be requested to write and share personal experiences related to the topics covered in the class. Students are expected to correct their mistakes, if any, on their homework, quizzes, and tests as soon as possible after they have been graded. The portfolio can serve students as a useful resource for studying for their examinations and also for the related advanced level courses. Students are also informed that the main purpose of homework is to learn the subject matter, and there is a strong correlation between effort on the homework and test scores (Yokomoto and Ware, 1991).

As the next event in the class period, a reading quiz (RQ) is given. The answers are recorded as explained above for the homework grades. After the answers are recorded, a verbal response from the class is obtained. This verbal response gives instant feedback to the instructor about the student responses to the quiz. The instructor then confirms and explains the correct response.

The homework checking and reading quiz process usually takes about ten minutes. Then various applications of the day's topic are discussed. These applications serve as an introduction to a mini-lecture addressing critical content. Included in this mini-lecture is coverage of one to two basic example problems. This process usually takes another twenty-two minutes (for a total of 32 minutes, thus far).

Following this first set of examples, students are given a set of concept quizzes (CQ). First, students are asked to record their individually-determined answers on the grade sheet. Then at the instructor's signal, students discuss the questions with their neighbors as an informal group activity. After discussion, students are asked to record a new set of answers (which could either be the same or different from their first set of CQ answers) on the sheet. As before, a verbal response from the class is solicited and the instructor provides feedback as discussed earlier. This conceptual quiz process takes about four minutes (for a running total of approximately 36 minutes).

Next, students participate in group-problem solving and tackle additional problems. This activity is budgeted to take about another 12 minutes (for a running total of 48 minutes). Finally, an attention quiz (AQ) is given (Mehta, 1993 & 1997). This quiz consists of two multiple-choice questions based on the main ideas emphasized in that day's class. This takes about two minutes (for a total of 50 minutes). The student's drop-off their grade sheets in a box kept near the classroom door as they leave the room.

Students can also be required to write a daily journal describing their learning in each class. Suggested topics are "What are the practical applications?" and "What are questions or things that are not clear?" The students are also requested to volunteer three hours of their time during the semester to help other statics students during the group problem solving sessions and help sessions. This is explained to students as a variation of service learning, with the classroom being considered a learning community. Student use a sign-up sheet to select two class periods and two one-hour times during the semester when they will serve as tutors. The student volunteers are required to study the group problem before the class period and to complete their homework before going to their help-session; thus, they are prepared to help other students as needed.

Various aspects of technology can be used in the course, as appropriate. The authors have used a standard web page containing course syllabus, schedule, etc. Links are provided to other web sites containing on-line multi-media modules on statics topics. Students Note files are also linked to the class schedule so students can access them before class. The reading quizzes, conceptual quizzes, and attention quizzes (and their solutions) are available on the web page soon after the class period in which the quizzes are taken. Exam solutions are also posted on the web. A CD-ROM containing Working Model, simulations can also be provided in the library for student check out. At North Dakota State University, a special web-based program is used to provide feedback on daily homework and quizzes to both students and instructor (Mehta & Schlect, 1998). A list-serve is used to send e-mail to all students, on an as-needed basis. At Arizona State University East, CourseInfo™ software is being used as a web-based platform to accomplish many of these same functions.

Conclusions

This paper describes and provides examples of pedagogy-based resource materials for statics instruction that were developed via collaboration between faculty at two universities, the National Science Foundation, and a commercial publisher. These resource materials encourage students to take ownership of their learning and help instructors turn classroom lectures into engaging discussions. Other aspects of the materials promote active cooperative learning and provide classroom assessment tools to provide quick feedback for both students and instructors.

A preliminary comparison of students' performance in two statics sections indicates that use of these NG Principals-based teaching materials seem to have a positive impact on student learning. During the early development of the NG Principals and the teaching materials, two sections of statics were used as a test and control groups. The control section had an enrollment of 51 students and was taught using a traditional lecture-based approach. The experimental section had an enrollment of 46 students and was taught using the pedagogy-based NG Principals-based resource materials. Each section had a different instructor but both are recognized by students as excellent teachers (measured by teaching awards, etc.). Post-semester data showed that students in both sections earned the same average semester GPA of 2.69. In the control section, 35 students (69%) passed the course (i.e., received an A, B, C, or D). In the experimental section, 41 students (89%) passed the course. Thus, the experimental section had a higher pass rate with 20% more students passing the course. Additionally, the performance of those students who had passed was monitored in two later courses, dynamics and mechanics of materials, both of which require statics as a prerequisite. Both of these later courses were taught using a traditional lecture-based approach. No significant statistical difference in performance between the control and experimental groups of students in these two follow-on courses was observed.

These preliminary results indicate that, on average, the 20% additional students passing the section using the pedagogy-based NGP-based resource materials performed at the same level as the fewer students passing the traditional lecture-based approach. These results are similar to those in Zunkel's (2000) learning community study at Iowa State University. She found that the retention rate of freshman students in the learning community increased from 70% to 83% but showed no significant difference in academic performance.

Other evidence from the literature cited in the Introduction also provides a strong foundation for the NG Principles and their implementation via the teaching materials described here. These materials are shared with other statics instructors for their use and experimentation. It is hoped that instructors will use these and other research-based resource materials in their classes with the thoughtful intent of observing and sharing the results with respect to student learning. Students report that they like the materials and this approach to teaching statics. However, direct evidence that increased student learning results from their use is limited. Those data are difficult to generate, given the absence of a reliable measurement tool, i.e., a validated and standardized test, for assessing student learning of statics concepts.

As noted earlier, NSF's Education Material Development (EMD) track of the Course Curriculum and Laboratory Improvement (CCLI) program can be used to develop teaching resources based on other emerging pedagogies like problem or inquiry-based learning. The Adapt and Implementation (A&I) track of the CCLI program is a possible funding source for adapting the statics model reported here to other SMET courses. Current feedback indicates that faculty at Southern University and A & M College, LA, plan to submit such proposals for developing resource materials for manufacturing and heat-transfer courses.

For instructors, these materials provide a template and model for teaching statics and other engineering subjects. Teaching both large and small enrollment sections becomes easier and more organized when using the materials. If nothing else, the three quiz sessions per lecture and the group interaction time enlivens the classroom and helps engage students in statics. Thus, the classroom is a more enjoyable place for both students and instructors.

Acknowledgements

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References

Angelo, T.A. & Cross, P. (1993). *Classroom Assessment Techniques: A Handbook for College Teachers*. Jossey Bass Publisher, San Francisco, CA.

Boyer (1998). "Reinventing Undergraduate Education: A Blueprint For America's Research Universities," A report from the Carnegie Foundation, http://notes.cc.sunysb.edu/Pres/boyer.nsf.

Cross, Patricia (1998). "What Do We Know About Student Learning and How Do We Know It?" *Proceedings of the 1998 AAHE National Conference on Higher Education*, Atlanta, GA.

Danielson, S.G., & Danielson, E.B. (1994). Teaching problem solving via non-traditional methods. In: *1994 Annual Conference Proceedings*, American Society for Engineering Education, Vol. II, June 26-29, Edmonton, Canada (p. 1675-1680). New York: American Society for Engineering Education.

ECS (1996). "What Research Says about Improving undergraduate education," AAHE Bulletin, April, pp. 5-8.

Hake, R. (1998). "Interactive-engagement versus traditional methods: A six thousand-student survey of mechanics test data for introductory physics courses," *Am. J Phys., 66* (1), 64-74.

Johnson, D., Johnson, R., & Smith, K. (1998). "Cooperative Learning returns to college: What evidence is there that it works?" *Change*, July/August, 27 - 35.

Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. Prentice Hall, Englewood Cliffs, NJ.

MacGregor, Jean, Cooper, J., Smith, K., and Robinson, P. (2000). *Strategies for Energizing Large Classes: From Small Groups to Learning Communities,* Jossey Bass Publisher, San Francisco, CA.

Mafi, M. (1989). "Involving Students in a Time-Saving Solution to the Homework Problem," Engineering Education, April, p.444.

Mazur, Eric (1997). *Peer Instruction*. Prentice Hall, NJ.

McKeachie, W. J. (1999). *Teaching Tips: Strategies, Research, and Theory for College and University Teachers*, 10th ed., Houghton Mifflin, Boston, MA.

Mehta, S. I. (1997). "Productive, Quick, and Enjoyable Assessment," *Proceedings, ASEE National Conference*, Milwaukee, WI.

Mehta, S., & Danielson, S. (2000a). Next Generation Principles for Enhancing Student Learning, *Proceedings of the ASEE National Conference*, St. Louis, MO.

Mehta, S.I. (1993). "An Attention Quiz; A Low-Tech, High Yielding Teaching Tip," *Proceedings of the 1993 ASEE Annual Conference*, Urbana, IL, pp. 1897-1901.

Mehta, S. & Schlecht, N. (1998). "Computerized Assessment Technique for Large Classes," *Journal of Engineering Education, Vol. 87*, 2, p. 167-172.

Morrison, R. T. (1986). "The Lecture System in Teaching Science," in "Undergraduate Education in Chemistry and Physics: Proceedings of the Chicago Conferences on Liberal Education," No. 1, edited by R.R. Rice (Univ. of Chicago), p. 50-58.

NRC (2000). *How people learn: Brain, Mind, Experience, and School (expanded edition).* National Research Council's Commission on Behavioral and Social Sciences and Education: Developments n the Science of Learning and Learning Research and Educational Practice. National Academy Press, Washington, D.C.. Full text can be found at http://books.nap.edu/catalog/9853.html

NSF (1996). *Shaping the Future: New Expectations for Undergraduate Education in Science Mathematics, Engineering, and Technology*, Report # NSF 96-139. The National Science Foundation, Arlington, VA.

Panitz, Beth (1996). "Boosting students' attention and retention," ASEE *Prism*, Vol. 5, 5, p.16.

Simon, Herbert (1998). "What We Know About Learning (Keynote Address)," *Journal of Engineering Education, Vol. 87*, 4, p. 433-436.

Yokomoto, C.F. and Ware, R. (1991). "The Seven Practices-Persuading Students to do Their Homework," *Proceedings of the ASEE Annual Conference*, New Orleans, LA, pp.1767-1769.

Zunkel, Karen (2000). "Impact of Learning Communities on Undeclared Engineering Students," *Proceedings of the ASEE North Midwest Conference*, Minneapolis, MN.

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