# A CET Videotaped Laboratory in Materials Testing - An Evaluation and Comparison with On-campus Delivery Methods

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## Abstract

This paper evaluates the videotaped version of the Materials Testing Laboratory course and compares it to the on-campus version of the course. The videotaped version was first offered in the summer of 1999 and has been offered to approximately 50 students each summer since that time. The initial method of assessment of the course was to compare the grades of laboratory experiments. It was later decided that the assessment method should include a proctored examination with questions keyed to specific objectives.

This proctored examination has been added to the course and the preliminary evaluation of the results indicates that the videotaped course delivery is not as effective in the delivery of the "how and why" concepts as the classes held on campus. Extenuating circumstances mandate that additional study of the relevant issues is appropriate. This effort is a positive outcome of ABET's mandate for continuing improvement in teaching.

## Introduction

The Engineering Technology Program at Old Dominion University offers ABET accredited options in Civil, Electrical and Mechanical Engineering Technology. In recent years this offering has been expanded to include emphasis areas in Surveying/Geomatics, Computer Engineering Technology and Nuclear Engineering Technology, one each under the umbrella of the three original programs. The Civil Engineering Technology (CET) curriculum is one of the degreed programs that are offered through the Old Dominion University Distant Learning (TELETECHNET) system. This distance learning program is one of the largest degreed distance education programs in the United States. The university is committed to providing our distance-learning students the same educational opportunities that are available to our on-site students.

Distant students typically earn an associate degree at their local community colleges and then attend Old Dominion University through the TELETECHNET system to earn their Baccalaureate degree in CET. The typical lecture courses are delivered in the synchronous mode and the students have great success in this manner.

In the summer of 1998, CET 345, Testing and Inspection of Construction Materials, was videotaped in the laboratory with all discussion, measurements and testing recorded[1]. These


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videotapes were used successfully in the fall of 1998 and the summers of 1999 and 2000 for the distant students. The success of the virtual approach to the CET 345 laboratory class was documented in the paper titled *Experiences With A Virtual Laboratory Class in Materials Testing For Civil Engineering Technology*[1]. The results indicated that the average grade for the videotaped classes based solely on laboratory report grades was higher than the average grade for the on-site classes.

Assessment and Objectives

It has been determined that an evaluation of the students' reports is a meaningful way to assess the students' performance[2]. CET 345 virtual laboratories were implemented based on our concurrence of this opinion.

It was decided however, that a more accurate result could be obtained if a proctored examination were added. This method of assessment was proposed for numerous laboratory classes at Old Dominion University in the past[3] and is currently in the process of implementation. The examination consisted of at least one question relevant to each experiment. The examination typically contains 10 multiple-choice questions valued at four points each, four short answer questions valued at 10 points each, and one final question requiring the preparation of the stress-strain curve that was valued at 20 points. Each of the questions relates to the objectives established for each experiment[4].

The distribution of grading for the on-campus sections and videotaped sections is shown in the table below:

TABLE 1 - Materials Testing Laboratory - Distribution of Credit

| Item | On-Campus | Videotaped |
|---|---|---|
| Preparatory Assignment or Quiz | 10% | 0% |
| Laboratory Report Grades | 80% | 90% |
| Final Examination | 10% | 10% |

Note that the campus students are required to do a preparatory assignment or take a quiz on the day of the experiment. This was instituted to assure some level of preparation that would enhance their performance on the experiment. This was not considered essential with the students taking the class by videotape, as they could review the tape as needed. This difference is not considered to affect the results of the assessment being discussed in this paper, since it is based solely on the final examination.

An additional advantage of the proctored examination is that it offers an increased assurance of academic honesty for a laboratory where the students are never seen. It is considered highly unlikely that a student that had not personally prepared a stress-strain curve for a laboratory report could do so accurately on a proctored examination. This is a reasonable expectation since each student is responsible for the preparation of his own laboratory report.


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Description of the Materials Testing Laboratory Course

Traditionally the class is held in a testing laboratory that is equipped with machines to facilitate this testing. At Old Dominion University, the laboratory has four tension/compression machines, two with a capacity of 60,000 pounds, one with a capacity of 400,000 pounds and a fourth for compression testing of concrete cylinders with a capacity of 250,000 pounds. Also available are machines to test impact, torsion, fatigue and hardness.

A typical semester will include ten experiments requiring fourteen class periods of up to three hours each. The class is usually limited to 16 students, with 20 being the maximum for an on-campus class. The schedule of experiments varies with the class broken into groups of not more than four or five students for some experiments. The entire class executes other experiments as a group. A typical class schedule is as follows with classes executed by the entire class group indicated by an asterisk:

Week 1 – Introduction*

Week 2 - Experiment 1 - Verification of a testing machine. Using a dynamometer, a testing machine's load readings are verified with adjustments for temperature. A graph indicating conformance with ASTM standards is developed.

Week 3 - Experiment 2 - Tension testing of metals. A tension test of a metal specimen is performed and material parameters determined. The parameters are compared to standard values and a stress-strain curve is drawn.

Week 4 - Experiment 3 - Hardness of metals. Using a Rockwell hardness tester, several metals are tested and corresponding values for Brinnel hardness and material yield strength are found.

Week 5 - Experiment 5 - Wood I. Specimens are testing in compression perpendicular to the grain and in bending. Parameters of the wood are obtained. Stress-strain curves are prepared and the parameters of the material are compared to standard values.

Week 6 - Experiment 5- Wood II. Specimens are testing in compression parallel to the grain. Parameters of the wood are obtained. A stress-strain curve is prepared and the parameters of the material are compared to standard values

Week 7 - Experiment 4 - Concrete I*. Concrete mix designs are discussed and prepared. Concrete is mixed and cast into compression cylinders and a beam. The cylinders and beam are stored in a moist room for curing.

Week 8 - Experiment 7 - Impact. Charpy and Izod specimens are tested and the values for different grades of steel are compared.


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Week 9 - Experiment 6 - Torsion. A steel rod is tested in torsion and properties for the specimen determined. A curve of torque as a function of angular displacement is prepared. Parameters of the material are compared to standard values.

Week 10 - Experiment 9 - Non-destructive Testing*. Metal specimens are measured and examined visually for defects. Specimens are tested for defects with magnetic particle and dye penetrant tests.

Week 11 - Experiment 4 - Concrete II*. The concrete cylinders and beam are tested and parameters for each determined. The estimated ultimate strength of each is compared to the values found by testing.

Week 12 - Experiment 10 - Fasteners. Single and double shear bolted connections are analyzed for the path of load through the connection. The connections are tested to failure and critical stress values determined.

Week 13 - Experiment 8 - Fatigue – Curves of stress verses number of cycles are prepared for smooth round, notched round and flat specimens. Values of the endurance ratio are determined.

Week 14 – Turn in last reports and final examination.

Distance Education Delivery Method

Students receive videotapes for each of the experiments listed above. They watch one tape weekly and are required to submit lab reports according to the schedule published in the course syllabus. The course syllabus is posted on the TELETECHNET web page so students can access it easily. Most correspondence between student and professor is via e-mail. The site directors deliver videotapes to the students at their distant sites and reports are submitted to the instructor through the TELETECHNET delivery system in order to verify that they are submitted as required.

As discussed in an earlier paper[1], the taped experiments were not presented in a highly polished format. Working together, a student and faculty member performed the experiments, as is typically done in the laboratory. In most classes, not all students are performing the tasks at hand. Often students are observing, or taking data, which is the assigned task of the "video" student.

One of the report requirements for both methods of delivery is to state what did not go well with the experiment, why it did not go well, and to suggest improvements in the process. A highly polished presentation leaves little information to fulfill this part of the report.


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Comparison of Final Examination Results

| | | EXAM QUESTION (CORRESPONDING EXPERIMENT) | CAMPUS SPRING 2002 | CAMPUS SPRING 2003 | CAMPUS SPRING 2004 | VIDEOTAPED SUMMER 2004 |
|---|---|---|---|---|---|---|
| Number of Students | | | 20 | 18 | 18 | 35 |
| Average Final Exam Grade | | | 81.0 | 79.2 | 86.6 | 68.2 |
| Average Points Received for Each Question | Maximum of 4 points | Question 1 (Exp. 1) | 2.40 | 3.33 | 4.00 | 2.40 |
| | | Question 2 (Exp. 1) | 3.40 | 3.77 | 3.78 | 2.28 |
| | | Question 3 (Exp. 4) | 3.80 | 3.77 | 4.00 | 2.97 |
| | | Question 4 (Exp. 5) | 2.20 | 3.33 | 3.78 | 2.86 |
| | | Question 5 (Exp. 3) | 3.20 | 3.11 | 3.60 | 3.31 |
| | | Question 6 (Exp. 6) | 3.80 | 2.22 | 2.67 | 3.31 |
| | | Question 7 (Exp. 7) | 2.60 | 2.00 | 3.43 | 2.74 |
| | | Question 8 (Exp. 8) | 1.80 | 3.77 | 3.56 | 2.97 |
| | | Question 9 | 2.70 (Exp. 10) | 2.88 (Exp. 8) | 3.78 (Exp. 8) | 3.20 (Exp. 9) |
| | | Question 10 (Exp. 9) | 3.86 | 4.00 | 4.00 | 3.67 |
| | Maximum of 10 points | Question 11 (Exp. 7) | 9.15 | 8.5 | 7.58 | 6.60 |
| | | Question 12 (Exp.10) | 8.15 | 8.66 | 8.94 | 5.77 |
| | | Question 13 (Exp. 9) | 9.55 | 8.44 | 10.00 | 8.49 |
| | | Question 14 (Exp. 3) | 8.10 | 6.88 | 8.28 | 5.37 |
| | Maximum of 20 points | Question 15 (Exp. 2) | 15.75 | 13.5 | 15.17 | 10.57 |


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Several observations are noted from the data above:

1. The results of the final examination were much better for the campus students than for the students that received the videotaped presentation. Since the principal goal of the final examination was to demonstrate mastery of the "how and why" aspects of the experiments, a comparably favorable result for the two groups was not realized.

2. An analysis of the data indicates that two of the students in the videotaped section were not active participants. Their grades on the examination overall were 8 and 36. If these two results were removed from the group, the results for the videotaped section would improve significantly.

3. The sample may have been too small. Critical data for the videotaped sections given in the summer of 2002 and 2003 were not available. Additional study in subsequent summers will be made.

4. Logistical problems for the students occurred with the videotaped section due to an irregularity in the manner in which the sections were established in the distance learning system which prevented a smooth and orderly handling of student papers at the first of the class. This difficulty may have hampered these students throughout the class.

5. The results for the campus group show a relatively poor performance to questions involving Experiment 3 (Hardness), Experiment 6 (Torsion), Experiment 7 (Impact) and Experiment 10 (Non-destructive Testing). In each incidence the results were not as good as those for the other questions.

6. A relatively poor performance was also noted for the videotaped section for questions relating to Experiment 1 (Verification of Testing Machine), Experiment 7 (Impact) and Experiment 3 (Hardness).

## Conclusion

It is critical to the success of the TELETECHNET degreed programs at Old Dominion University that the distant learning students receive an education that is equivalent to that of the on-site students. This issue is critical to the continued accreditation of the distance education programs.

The above results indicate that it would be appropriate to examine the emphasis placed on the "how and why" concepts presented on the videotaped version of the class. This may require modifications to the recorded sessions, or supplemental material to reinforce the understanding of some concepts.

In consideration of the other observations it is advisable to obtain more data especially now that the unusual and unexpected irregularity in the handling of student papers has been identified and resolved. Specific issues involved with the areas of relative weakness in certain areas must be addressed, which is the essential element in any assessment process.


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