Student Assessment: A Pre-test and Post-test Experiment with Undergraduate Students in Finance

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The authors of this paper utilized a "background knowledge probe," in the form of a short, simple, non-graded, anonymous, in-class multiple-choice exam to determine prior and post learning. This instrument was was administered to an Essentials of Finance class in the Fall of 2015. The authors analyzed the results utilizing both a paired t-test test and a "Bootstrapping" technique. Analysis results indicate a significant change in the performance of the the 'before class' as compared to the 'after class' populations. Three full professors in Finance derived the test instrument to ensure the validity of the project. The authors plan to address the instrument's reliability over subsequent semesters.

INTRODUCTION

Assessments in the classroom have taken various developmental modifications since Angelo, T.A. and Cross, K.P. (1993) published *Classroom Assessment Techniques*. These Classroom Assessment Techniques (CATs) were devised to enhance university teaching and learning. According to the Center for Teaching at Vanderbilt University (2016), instructors should implement CATs for the following reasons.

1. Provide "just-in-time' feedback concerning the teaching-student learning process.
2. Provide information concerning student learning with more efficient effort than a traditional assignment (i.e., exams, reflection papers, research papers, presentations, etc.).
3. Encourage both professors and students to embrace the ongoing process of inquiry, experimentation, and course reflection.
4. Assist students in becoming better monitors of their own learning.
5. Help students to feel less anonymous, even in very large classes.
6. Distribute solid evidence that instructor care as much about the learning process as do students.

The Center of Teaching at Vanderbilt University (2016) purports that the incorporation of CATs into the classroom curriculum should have the following considerations. A professor should:

1. Determine precisely what he/she wants the CAT to assess regarding students' learning.
2. Select a CAT that is easily implemented in class and provides appropriate feedback; the feedback should be consistent with the instructor's teaching style.
3. Explain the meaning and purpose of the assessment activity being used.
4. Inform students what can be learned by the use of CATs, and how the assessment information generated will be utilized.
5. Review with students the assessment results regarding their learning or lack thereof and propose changes aimed at improving student learning.

According to the Walker Center for Teaching and Learning (2016), efficient classroom assessment does not demand specialized training; it can be adequately carried out by teachers of all disciplines. In this study, a professor in finance and one in operations management examine whether beginning students in finance can improve learning from covering various classroom topics studied over a semester in an Essentials of Finance course. Since skills in problem solving were assessed, the Walker Center assessment suggestions for the classroom milieu were followed. The assessment strategy was modified slightly in that students were initially given a pre-test of ten carefully chosen multiple-choice questions that specifically addressed subjects that would be covered throughout the semester. After covering course material, a post-test covering the same questions was administered. The pre-test and post-test results were then compared and contrasted. Exhibit 1 contains a list of the pre/post test questions.

Pre- and post-tests are direct methods of assessment. Janet Fulks and Marcy Alancraig differentiate between the various forms of assessment in their paper "Course Assessment Basics: Evaluating your Construction" They build upon the work of Angelo and Cross" (1993), and state that CATs are "simple tools for collecting data on student learning in order to improve it." According to Fulks and

Alancraig, data from CATs are evaluated and implemented in order to facilitate continuous modifications and improvement in class. Embedded assessment links student learning outcomes through primary trait analysis serving as grading and assessment instruments. Questions on exams can be "embedded to offer assessment information to a departmental, program or institutional body."

According to AACSB Assurance of Learning Standards (2013), "course-embedded" measures relate to specific course assignments – this may also be used for outcomes assessment purposes. According to "Classroom Assessment and Course-Embedded Assessment – What's the Difference?" article from the University of Wisconsin at Whitewater, course-embedded assessment usually takes place when general education committees or departments collect assessment data for program or institutional activities. The most frequent examples would include capstone courses and student portfolios. In other words, course-embedded assessment is the recycling of student work. Classroom assessment is different in the sense that it covers a variety of techniques (CATs) to produce data for instructional improvement or for monitoring student learning. Angelo and Cross (1993) believe that CATs assist individual professors in processing beneficial feedback on what, how much, and how well their students are learning. They believe that course-embedded assessment is intended to offer information for assessment for the program or general education level, while classroom assessment data is supposed to provide information that is particularly useful to the professor, who can ultimately improve their individual course. In addition, the student product forming the CAT is customarily not graded by the instructor because the intent is generally to offer data for learning improvement.

METHODOLOGY AND RESULTS

In our examination of student learning, a pretest/posttest format was utilized; this direct assessment tool was graded by the university's technology center. The pre-test was given to students on the first day of class, and the post-test was administered to students on the last day of class. An exam with ten general questions on the basic concepts in finance was used as our instrument to test general knowledge in the finance discipline (See Exhibit 1). This exam was designed and implemented by the finance faculty at a small private university in the Midwest. The selected exam was submitted for approved to the undergraduate curriculum committee, and was unanimously accepted. It also passed our University's validity requirement.

These exams were tied to the course's learning objectives, which were as follows:

1. Read, analyze and interpret financial statements and financial ratios.
2. Value stocks and bonds by interpreting bond quotes and calculating bond values and yield to maturities.
3. Determine the cost of capital, and explain the impact of dividend policy choices.
4. Explain an organization's capital structure.
5. Calculate and use financial and quantitative techniques, such as time value of money and return on investment.
6. Select and calculate appropriate capital budgeting techniques to evaluate projects.

When analyzing the resulting data, the authors utilized two different statistical techniques to create a confidence level of statistical significance. We first employed a paired t-tests technique. Rosie Shier (2004) in her explanation in the Mathematics Learning Support Centre cites the appropriateness of the paired t-tests analysis when there is a comparison of before-and-after observations on essentially the same subjects. This is ideal for us since we applied a student's diagnostic test results before-and-after an introductory course in Finance. In order to test the null hypothesis that the true mean difference is zero, we performed the following steps: (a) calculated the difference between two observations on each pair of testing; (b) found the mean difference; (c) computed the standard deviation of the differences; (d) calculated the t-statistics; and (e) compared and contrasted our values. Refer to Exhibit 2 for individual student responses and mean values. As shown below in Table 1, our test results indicated a mean pre score of 3.44 versus a post value of 5.24. The t-stat was 3.78 with a p value of .00046.

Table 1. Results t-Test: Paired Two Sample Means

	PRE-MEAN	POST-MEAN
Mean	3.44	5.24
Variance	1.59	4.19
Observations	25	25
Hypothesized Mean Difference	0	
df	24	
t Stat	3.780756	
P(T<=t) one-tail	0.000458	
t Critical one-tail	1.710882	

The analysis of data without checking distribution assumptions can also be completed with bootstrapping techniques. The theoretical underpinnings of this method are examined by Diaconis and Efron (1983) who describe bootstrapping as a computer intensive technique that resamples collected data to study the behavior of a distribution of a specific statistic. As a result, inferences are

made on populations that are parametric as well as nonparametric.

Bootstrapping is a numerical sampling technique where the data sampled are re-sampled with replacement. Within this technique, a researcher first acquires a sample, next replaces the sampled values back in the pool, and then then selects another sample. In this way, sample data is obtained from which summary statistics can be generated for each re-sample. Various descriptive statistics such as mean, median, mode, variance and correlation can be bootstrapped. With the use of a computer, a researcher can create many re-samples. Bootstrapping techniques allows the researcher to analyze any distribution and make inferences. The sample data becomes the population and the re-sampled data are the samples.

Bootstrapping with Data Analysis Tool-pack Resampling with replacement can be done easily in Excel by following these steps:

1. Install and-ins Data Analysis Tool-pack and Data Analysis Tool-pack VBA.
2. Under 'Tools' select 'Data Analysis'.
3. Select 'Sampling'.
4. Highlight the data you wish to resample.
5. Select a range where you want resampled data to be placed.
6. Select the number of samples you wish.
7. Click on enter and your resampled data is displayed to the specified output location.

The authors found, when utilizing the bootstrapping technique, a one-tail test a t-statistic of -10.49 with an almost non-existent p value of 9.61×10^{-11} (Refer to Table 2 for results). With ten different paired samples, the authors are quite confident these results indicate positive learning has taken place.

Table 2. Results from Bootstrapping Technique

	PRE-MEAN	POST-MEAN
Mean	3.4	5.044
Variance	0.138333333	0.354233333
Observations	25	25
Hypothesized Mean Difference	0	
df	24	
t Stat	-10.48830062	
P(T<=t) one-tail	9.61E-11	
t Critical one-tail	1.71088208	

REFLECTIONS AND RECOMMENDATIONS

The authors were pleased to see positive statistical results from exams taken by Essentials of Finance students in the Fall of 2015. Both the paired t-tests and the bootstrapping techniques suggested that learning occurred. We realize that results from a single class does not imply that every subsequent class will demonstrate significant improvement in learning, although we would be quite disappointed if this was not the case. We did not share the assessment results with our students; in the future, we plan to share this information with students as we feel receiving this feedback would be very important.

The assessment exam was graded (assessed), but it did not influence student grades for the course. Enerson, Plank, and Johnson (2007) at Penn State University debate whether student performance should be anonymous. Cross and Angelo (1993) recommended that classroom assessments be ungraded, but Enerson, Plank, and Johnson (2007) suggest that attributing even one percent of the final grade to the assessment might encourage the students to take the exam more seriously. They do purport that CATs work best when they are used as a feedback source and not as an evaluation system. At present, the authors of this paper lean toward not using the assessment exercise for any grading purposes. In the future, the authors plan to require names on the exam, with better explanations from the instructor about the purpose of the exam (pre-exam vs post exam), and finally provide individualized feedback to each student on their improvement from the pre-exam to the post exam

Three full professors in Finance derived the test instrument to ensure the validity of the project. The authors will address reliability over subsequent semesters. Although the authors are quite confident on the validity of the exam questions (i.e., following the various finance concepts taught throughout the class), we are keenly interested in testing reliability over the next few years.

We do not believe that survivor bias existed in our study. There were no drops in this particular class, however there

were a few absences on the post exam due to scholar athletes participating in out-of-town sporting events. The scholar athletes missing were all excellent students, so we are confident that survivor bias was not present.

The authors aspire to create more ways to understand the classroom assessment process. We will incorporate many of Kathy Dyer's (2015) seven ways to understand better classroom assessment. In the future, we plan to incorporate learning activities that follow Dyer's (2015) guidelines:

1. Regularly pinpoint and share learning exercises with your students.
2. Continuously produce evidence of student learning.
3. Adapt instruction and guidance to meet your students' immediate learning needs.
4. Provide feedback in order to progress learning forward, and then create a structure for students to act on it.
5. Know that students will welcome and will potentially act on this feedback.
6. Students will be more engaged when they feel involved in the classroom.
7. Allow opportunities for students to support each other and begin to accept partial responsibility for their own learning.

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EXHIBIT 1: FN 3000-Essentials of Finance Assessment Questions

1. What is the primary goal of financial management?
   A. Increased earnings
   B. Maximizing cash flow
   C. Maximizing shareholder wealth
   D. Minimizing risk of the firm

2. Earnings per share is
   A. operating profit divided by number of shares outstanding.
   B. net income divided by number of shares outstanding.
   C. net income divided by stockholders' equity.
   D. net income minus preferred dividends divided by number of shares outstanding.

3. Asset accounts on the balance sheet are listed in the order of:
   A. liquidity.
   B. profitability.
   C. size.
   D. importance.

4. The statement of cash flows does not include which of the following sections?
   A. Cash flows from operating activities
   B. Cash flows from sales activities
   C. Cash flows from investing activities
   D. Cash flows from financing activities

5. Which two ratios are used in the DuPont system to create return on assets?
   A. Return on assets and asset turnover
   B. Profit margin and asset turnover
   C. Return on total capital and the profit margin
   D. Inventory turnover and return on fixed assets

6. The concept of operating leverage involves the use of _____ to magnify returns at high levels of operations
   A. fixed costs.
   B. variable costs.
   C. marginal costs.
   D. semi-variable costs levels of operation.

7. As the interest rate increases, the present value of an amount to be received at the end of a fixed period
   A. increases.
   B. decreases.
   C. remains the same.
   D. Not enough information to tell.

8. Which of the following financial assets is likely to have the highest required rate of return based on risk?
   A. Corporate bond.
   B. Treasury bill.
   C. Certificate of Deposit.
   D. Common stock.

9. Capital budgeting is primarily concerned with
   A. capital formation in the economy.
   B. planning future financing needs.
   C. evaluating investment alternatives.
   D. minimizing the cost of capital

10. Risk may be integrated into capital budgeting decisions by
    A. adjusting the standard deviation of possible outcomes.
    B. determining the expected value.
    C. adjusting the discount rate.
    D. adjusting the time horizon.

EXHIBIT 2: Pre-Mean vs. Post-Mean

Response	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	PRE-MEAN
1	3	2	4	2	4	4	7	4	5	3	3.8
2	4	3		2	2	4	4	3	3	3	3.0
3	2	2	2	4	5	3	4	2	3	2	2.9
4	2	2	4	2	4	3	4	2	4	4	3.1
5	4	4	2	5	4	2	4	4	3	7	3.9
6	2	2	5	2	2	4	3	2	4	4	3.0
7	3	4	3	3	2	4	3	2	7	2	3.3
8	5	4	2	4	3	2	4	2	4	3	3.3
9	5	5	5	7	4	2	2	4	4	2	4.0
10	2	3	4	2	4	4	5	3	2	4	3.3
11	3	3	5	4	3	4	3	3	5	3	3.6
12	4	4	2	4	2	3	4	4	2	5	3.4
13	3	5	5	5	5	2	3	5	2	2	3.7
14	4	4	3	3	2	3	3	3	7	4	3.6
15	3	5	5	4	3	2	7	4	5	4	4.2
16	4	3	4	4	4	3	3	3	2	4	3.4
17	3	5	3	5	3	2	4	5	4	5	3.9
18	4	3	2	4	2	4	3	5	5	3	3.5
19	7	4	2	2	4	4	4	2	2	2	3.3
20	2	4	4	2	2	3	2	2	3	7	3.1
21	3	5	2	3	3	4	2	2	5	3	3.2
22	4	4	4	5	7	3	2	2	2	3	3.6
23	2	4	3	4	3	4	2	4	2	2	3.0
24	2	5	2	3	2	4	4	2	3	4	3.1
25	5	2	3	4	2	2	2	4	2	2	2.8

Response	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	POST- MEAN
1	4	1	3	4	8	1	6	5	4	6	4.2
2	7	7	4	6	5	7	6	6	1	9	5.8
3	4	3	6	8	5	5	9	5	7	8	6.0
4	5	7	4	7	4	5	6	5	8	5	5.6
5	6	7	6	7	2	5	6	5	6	6	5.7
6	7	7	1	6	5	7	1	1	6	1	4.3
7	6	7	6	1	7	1	5	7	6	6	5.2
8	1	7	7	5	1	4	6	5	7	6	4.9
9	5	4	7	1	6	4	6	6	3	6	4.8
10	5	6	4	4	7	0	6	7	5	4	4.9
11	4	5	5	5	1	5	4	1	6	6	4.2
12	5	7	6	5	6	4	6	5	9	5	5.8
13	5	5	1	6	6	7	1	1	1	7	4.0
14	1	5	7	5	7	6	6	4	9	1	5.1
15	5	5	6	1	7	5	7	5	4	1	4.6
16	6	5	3	4	4	6	6	4	6	5	4.9
17	6	4	5	6	5	5	3	7	4	9	5.4
18	6	7	7	7	5	1	6	1	1	6	4.7
19	7	6	4	6	3	5	4	6	7	7	5.5
20	7	5	4	6	8	1	9	6	7	8	6.1
21	4	1	5	5	6	7	6	5	1	6	4.6
22	7	4	6	8	1	7	7	6	4	3	5.3
23	6	7	1	5	1	6	6	7	1	5	4.5
24	8	6	7	6	7	3	1	6	5	7	5.6
25	4	8	6	1	5	8	7	6	1	5	5.1