SECTION C

Using Direct Assessment to Improve Student Learning in a General Education Course Also Required in a Degree Program

Dr. Thomas E. Sieland

Embry-Riddle Aeronautical University – Worldwide

ABSTRACT

General Education "Program" outcomes were developed and used to guide the assessment of student learning in a physics course. The student learning outcomes that mapped to program outcomes included assessing students' problem solving skills. The results of student performance on a summative exam in sections of PHYS 102 in the October 2008 term were compared to specific overall and content assessment goals. The author used a focus group to review the results and make recommendations for improving student learning. Changes were implemented to improve student problem solving skills, in a formative sense, prior to students taking the assessment in future sections of the course. The changes resulted in measureable improvement in student performance.

Introduction: The Assessment Landscape Changes

Over the past several years, government and accrediting agencies have published documents that caused institutions to take an introspective look at assessing student learning and institutional effectiveness overall. In 2003, the Council of Regional Accrediting Commissions (CRAC) published the Regional Accreditation and Student Learning: Principles for Good Practice in which they outlined a set of principles that dealt with assessing student learning. For example, the document states:

> Based on this increased experience and in response to heightened public attention to issues of educational effectiveness, accrediting commissions have revised their standards and evaluation processes to make the focus on student learning outcomes central to the accreditation review process (p. 2).

In 2005, James and Karen Nichols et al published *A Road Map for Improvement of Student Learning and Support Services Through Assessment* in which they provided a new assessment paradigm that was destined to be a road map for not only assessment, but also accreditation. A few years later the government created a commission to study postsecondary education effectiveness. Finally, the Southern Association of Colleges and Schools (SACS) changed the focus of their accreditation to accentuate the need for institutions to directly assess student learning as evidenced in their most recent *Resource Manual for the Principles for Accreditation: Foundations for Quality Enhancement.* (2009)

The Council of Regional Accrediting Commissions Leads the Way

In their 2003 publication Regional Accreditation and Student Learning: Principles for Good Practice, the council provides both institutions and accrediting agencies excellent principles upon which an institution can formulate a concept of assessment of student learning. One must remember these principles were developed with the assistance of all regional accrediting agencies in the United States, including SACS. The principles were also designed to provide some standardization across accrediting regions. The five principles that apply to institutions or "What an accrediting commission should reasonably expect of an institution" (p. 3) are as follows:

1. The Centrality of Student Learning in its Mission. In other words, does the university's mission statement embrace student learning as important to the success of the university and their students? Without the focus of the university mission on student learning the assessment programs would lack a significant linkage from the university mission all the way down to the assessment of student learning in a course in a degree program.
2. Documentation of Student Learning. When we the institution indicate we will focus on student learning, conducting and documenting the results of the assessment are the evidence we will need to provide to show we are complying with SACS core requirements and comprehensive standards, as we will address later in this paper. The CRAC principles provide specific guidance that institutions should address and they are:
    a. "setting clear learning goal, that speak to both content and level of attainment;
    b. collecting evidence of goal attainment using appropriate assessment tools;
    c. applying collective judgment as to the meaning and utility of the evidence; and

d. using this evidence to improve its programs" (p. 3).

3. Compilation of Evidence. This principle implies that an institution needs to draw evidence from a number of sources that are complimentary. For example, using indirect assessment of student learning by using employer, alumni and student end of course surveys to guide assessment planners in what they should focus on when designing an assessment program.
4. Stakeholder Involvement. This principle deals with the concept of including students, faculty and other interested parties in reviewing and interpreting assessment results. In other words, the assessment efforts should not be an individual effort but the collective efforts of a number of interested parties. This principle certainly applies to the assessment of general education competencies across the curriculum.
5. Capacity Building. This principle indicates that an institution needs to have a robust assessment program that is designed to continually improve student learning during the entire academic career of a student. (CRAC, 2003)

It is interesting to note that these principles all apply to the various aspects of the road map that the Nichols outline in their book

The Nichols Model Provides a Sound Basis for Assessment

In their book on assessing student learning and support services, the authors provide a new paradigm for assessment that included the following items:

Establishment of an Expanded Statement of Institutional Purpose; Identification of Intended Educational (Student Learning) Research and Service Outcomes/Administration Objectives; Assessment of the extent to which the

Intended Outcomes and Objectives are being accomplished; and Adjustment (improvement) on the Institution's Purpose, Intended Outcomes/Objectives, or activities based on assessment findings (Nichols, 2005, p. 14).

Interestingly enough, ERAU developed their Embry-Riddle PowerPlanning (ERPP) system as a derivative of the Nichols' five step process. We have been using the ERPP system as the basis of assessment and planning for several years and now have evolved the assessment process to the point where we are directly assessing student learning. The evidence of the assessment resides in the ERPP system.

The Spelling Commission States the Case for Assessment

In 2006, the US Department of Education published the Spellings Commission Report, *A TEST OF LEADERSHIP charting the Future of US Higher Education, A Report of the Commission Appointed by Secretary of Education Margaret Spellings,* that engendered significant discussion within the postsecondary education system in the United States. In discussions with Dr. Richard Roach, EV for IE we came to realize that if colleges and universities did not take assessing student learning seriously, we could have a system of assessment defined for us. Some of the pertinent results encapsulated in the Spellings Commission report include the following:

1. A distinct reference to student learning as being an important aspect of assessing institutional effectiveness in our universities. The report states: "As other nations rapidly improve their higher education systems, we are disturbed by evidence that the quality of student learning at U.S. colleges and universities is inadequate and, in some cases, declining" (p. 3). The report goes on to imply that universities are not graduating students with the basic skill sets that are of value to employers in

the United States. As the report states: "Employers report repeatedly that many new graduates they hire are not prepared to work, lacking the critical thinking, writing and problem-solving skills needed in today's workplaces" (p. 3).

2. The Spellings Commission clearly implies that institutional effectiveness and assessment must be a culture of continuous improvement and not simply a snapshot in time. The report states: "We recommend that America's colleges and universities embrace a culture of continuous innovation and quality improvement. We urge these institutions to develop new pedagogies, curricula and technologies to improve learning, particularly in the areas of science and mathematics" (p. 25). The finding by the commission coincides with what Nichols and Nichols express in their book, *A Road Map for Improvement of Student Learning and Support Services Through Assessment.* The Nichols five-step assessment process, which is the basis for current institutional effectiveness at ERAU, incorporates direct assessment of student learning as a key aspect of improving the quality of student learning. (Nichols, 2005) In addition, the Council of Regional Accrediting Commissions report contains numerous references to directly assessing student learning.

SACS Embraces the CRAC Principles

In 2007, SACS changed their principles of accreditation to reflect a focus on assessing student learning that embraced both the Nichols' road map and the CRAC principles. In fact, Nichols stated in their book:

> Beyond any reasonable doubt , the Commission on Colleges of the Southern Association of Colleges and Schools expects each educational program (including

general education and where appropriate developmental education), as well as every administrative and educational support (AES) unit to have fully implemented the paradigm … and be able to document substantive change or improvements resulting from that implementation (P. 16).

The statement became pertinent when the new SACS comprehensive standards were issued around the year 2007. Prior to that time, SACS primarily looked at inputs and did not dwell on outputs or outcomes. That all changed and now the core requirements and comprehensive standards address direct assessment of student learning. This is particularly true of the statements in the SACS manual that deal with assessing general education competencies. A look at the applicable core requirement and comprehensive standards reveals the need for an institution to make sure it has a comprehensive assessment program.

Core requirement 2.5 in the SACS manual states, "The institution engages in ongoing, integrated, and institution-wide research-based planning and evaluation processes that incorporate a systematic review of programs and services that (a) results in continuing improvement and (b) demonstrates that the institution is effectively accomplishing its mission" (SACs, 2009, P. 9) In other words, any institution applying for accreditation or reaffirmation of their accreditation must provide evidence in their certificate of compliance that they are engaged in a robust assessment program. SACS goes on to provide notes concerning the core requirement (CR) and how it is linked to certain comprehensive standards (CS) in the manual. Specifically, the manual states:

Note: CR 2.5, CS 3.3.1, and CS 3.4.1 all relate directly to institutional effectiveness but each addresses a different aspect. CR 2.5 requires that an institution have an

> effective process for producing improvement and accomplishing its mission. CS 3.3.1 requires that an institution identify outcomes (resulting from the process required in CR 2.5), evaluate achievement of those outcomes, and demonstrate improvement based on the results of that evaluation. This applies to all educational programs and all administrative and support services. CS 3.4.1 requires that each educational program offered for academic credit establish and evaluate student learning outcomes (SACs, 2009, p. 9).

Clearly the need to assess student learning both directly and indirectly must be inherent in the evaluation of institutional effectiveness at any university wanting to maintain its accreditation. Although the core requirement and comprehensive standards signify assessing student learning within degree programs, SACS also addresses the assessment of student learning associated with general education core competencies.

SACS View on General Education Competencies

In the most recent version of the SACS principles, there is specific reference to what is expected of an institution as relates to the development and assessment of general education competencies. "Comprehensive Standard 3.5.1 The institution identifies college-level competencies within the general education core and provides evidence that graduates have attained those competencies" (SACS, 2009, p. 49). In order to comply with this standard, the Department of Arts and Sciences, in cooperation with the other academic departments in ERAU – W, need to identify a set of general education competencies and address how to assess that students graduating from degree programs have attained those competencies. As a result of reviewing all of the requirements for accreditation, the Department of Arts and Sciences, ERAU – W proceeded in developing general education outcomes specific to the general education component of degree programs, met with representatives of the other academic departments to establish a set of Worldwide general education competencies and formulated a rolling two-year plan to directly assess student learning. These actions demonstrate a continuing commitment to improving student learning in courses under the purview of the department.

Arts and Sciences Assessment Program

Beginning in the year 2006, the Department of Arts and Sciences ERAU-W began a deliberate process to develop a comprehensive assessment program for general education courses. The first step in the process was to use information already available from ERAU Institutional Research (IR) to guide its efforts to develop what could be considered general education "program" outcomes. Although the department does not have any degree programs that would require program outcomes, the department decided to tread the general education component of degree programs as a quasi-program. Thus the department refers to their outcomes as "program" outcomes. After analyzing employer and alumni survey data provided by IR, members of the department established a draft set of program outcomes. The department then met face-to-face to finalize the set of program outcomes and refined the draft set into the current set of 14 program outcomes. These program outcomes were then condensed into a set of draft General Education Competencies that were briefed to the departments and the Worldwide Faculty Senate, and eventually gained acceptance as Worldwide General Education Competencies. Finally, the department used the information at hand to develop a two-year assessment program that would eventually ensure that all program outcomes were assessed in a program of continual quality improvement.

Employer and Alumni Survey Data Show the Way

In the fall of 2006, the author took the existing employer and alumni survey data available from ERAU IR and conducted a thorough analysis of the data to see if we could use the data to provide intelligence concerning what was important to employers and alumni. The members of the Arts and Sciences Department used the results of the analysis to develop an initial set of general education program outcomes, which were refined into a final set of program outcomes during a daylong department meeting. The General Education Program Outcomes are provided in Appendix A. Dr. Terri Maue reported on the results of that analysis as part of her presentation to the Fifteenth Annual Symposium on Teaching and Learning Effectiveness, Presented by the Faculty of ERAU Worldwide October 24, 2007 that addressed learning outcomes in an English course. Appendix A of her report explains the system this author used to analyze the IR data and results of the analysis as relates to the Bachelor of Science in Professional Aeronautics degree, which this author focused on when conducting direct assessment of student learning in a physics course that is a required course in the degree program. (2007) Figure 1 shows the top 10 skills that employers indicated as being important by virtue of their responses to the employer surveys conducted by ERAU IR.

Skills Important to Employers BSPA Analysis	Top 10 Skills
Quantitative/mathematics	1
Basic PC software (word processing, spreadsheets, etc.)	2
Writing skills (non-technical)	3
Technical writing	4
Speaking before an audience	5
Applied research (information gathering and analysis)	6
Critical thinking	7
Independent work	8
Planning, scheduling, and carrying out projects	9
Defining and solving problems	10

Figure 1. Top 10 skills important to employers of students with the BSPA.

The number one skill deals with quantitative/mathematics, while the number ten skill deals with defining and solving problems. This author used these results to ultimately guide what learning outcomes in a physics course would be used to address the pertinent program outcome. Once the department finalized the general education program outcomes, the next step in the process was to map the learning outcomes in general education course outlines to the program outlines.

Worldwide General Education Competencies

Once the Arts and Sciences Department established its set of 14 general education program outcomes, the members of the Worldwide Assessment Committee took the 14 outcomes and developed a set of six general education competencies the committee deemed appropriate for all students to have the competencies as part of their skill set when they graduate from ERAU. The six general education competencies are provided in Figure 2.

Critical Thinking

The student will apply knowledge at the synthesis level to define and solve problems within professional and personal environments.

Quantitative Reasoning

The student will demonstrate the use of digitally-enabled technology & analysis techniques to interpret data for the purpose of drawing valid conclusions and solving associated problems.

Information Literacy

The student will conduct meaningful research, including gathering information from primary and secondary sources and incorporating and documenting source material in their writing.

Communication

The student will communicate concepts in written, digital and oral forms to present technical and non-technical information.

Scientific Literacy

The student will be able to analyze scientific evidence as it relates to the physical world and its interrelationship with human values and interests.

Life Long Personal Growth

The student will be able to demonstrate the skills needed to enrich the quality of life through activities which enhance and promote lifetime learning.

Figure 2. Worldwide General Education core competencies.

These general education competencies have been reviewed and generally accepted by the academic departments in ERAU-W.

Mapping General Education Course Learning Outcomes to Program Outcomes

At the Fifteenth Annual Symposium on Teaching and Learning Effectiveness, Presented by the Faculty of ERAU Worldwide October 24, 2007 Kelly George presented a methodology for mapping learning outcomes (LOs) in a general education economics course outline to program outcomes (POs) that are in turn linked to the ERAU mission. (2007) The department decided to use the methodology as the basis of their assessment program and proceeded to develop a matrix that showed which learning outcomes in each general education courses mapped to particular program outcomes. The matrix showing the results of the analysis is found in Appendix B. From the analysis, the department members identified eight key indicator courses that had multiple LOs that mapped to POs. The department then decided to conduct direct assessment of student learning in a subset of the key indicator courses, one of which is PHYS 102, Explorations in Physics, during the first year of their assessment program.

The General Education Assessment Program – Year One

The Arts and Sciences Department decided to develop a two year rolling assessment plan that would be updated each year to have a continual two year plan in effect. For the first year of the plan, the department selected eight indicator courses, two courses for each discipline in the department that had multiple LOs mapped to POs. Each discipline chair then determined which LOs in the courses would be used to directly assess student learning during the fall term on 2008. The results of the assessment would then be analyzed and changes recommended aimed at improving student learning. Since the course outlines are what guide instructor is delivering course content in the Worldwide, the changes were to be reflected in the annual update to the course outlines. This author participated in the first year of the program and assessed student learning associated with mathematics and problem solving in the online PHYS 102 course and his PHYS 102 course taught in the classroom face to face. The results of the assessment were used to make changes to the online PHYS 102 course and the PHYS 102 course outline.

Assessing Student Learning in a Physics Course

As part of the Department of Arts and Sciences assessment program for the 2008-2009 assessment cycle, one of the courses used to directly assess student learning linked to program outcomes was PHYS 102, Explorations in Physics. Since we were assessing student learning in four online sections and one classroom section, this author decided to use data from the online course sections exclusively in this report for reasons of consistency. The online course was designed with a variety of student aids and activities designed to help students develop problem solving skills in a formative sense. The students were provided videos about how to solve physics problems that used example problems from the first three chapters in the text. In addition, we provided an extensive set of PowerPoint slides that also had step-by-step examples of problem solving. The students also had access to video clips of actual physics experiments in order to gain a better understanding of the concepts provided in the text as well as HippoCampus tutorials that delved into the concepts in the text. Each module had a series of graded activities covering concepts in the first three chapters in the textbook. These activities were assessed and students were provided feedback. After the first three chapters were covered and all formative activities were assessed, the students were given a summative exam to test their understanding of the concepts and their ability to solve problems.

Direct Assessment of Student Learning in a Physics Course

The first summative exam in PHYS 102 was used as the basis for collecting data on student success. The Grade Center in the Learning Management System in

Blackboard provides both column statistics, that include the average and median grade for the assessment, and attempt statistics that include the average score for each question in the assessment. These data were extracted from four online sections in the fall of 2008 and the spring of 2009. The data were transferred to an Excel spreadsheet to facilitate analysis of the data. It should be noted here that we basically used convenience sampling and not a systematic type of sampling when collecting the data. Therefore, the results from statistically processing the data cannot be viewed as being definitive and any inferences obtained from the results of statistical testing are limited. Nevertheless, for demonstration purposes, we will present a statistical analysis of the data.

The Overall Goal for Assessing Student Learning

When we developed the assessment program for PHYS 102 as part of the Arts and Sciences Assessment Program, we set an overall assessment goal that 90% of the students would receive a grade of 80 or above on the exam. The detailed results of the overall assessment goal are provided in Appendix A. In summary, the fall sections had an average grade of 74.64, while 29 out of 61 students (48%) receiving a grade ≥ 80, compared to the spring sections that had an average grade of 75.62, while 26 out of 67 students (43%) receiving a grade ≥ 80. Neither group attained the overall criteria for success of 90% of the students taking the assessment receiving a grade ≥ 80.

The Content Goal for Assessing Student Learning

We set a content goal that no single question would have an average score of less than 70% of the available points for the question. After reviewing the results from the fall term assessment (see Appendix A for detailed results), we convened a focus group to discuss what steps we changes we could make to improve student learning. As a result, we agreed to the following actions that are detailed in the Educational Program Outcome Report prepared by the author, dated March 1, 2009 and revised July 2009 (See Appendix B for a copy of the report):

1. After we launched a reorganization of the PHYS 102 online course in February 2009, we held a teleconference with several physics instructors who had taught the course to review the data collected and as a team made recommendations to improve student learning in the course. The recommendations of the focus group have been incorporated in the updated version of this report.
2. The focus group reviewed all PowerPoint slides for the course and the course developer added examples of problems that demonstrate how to solve physics problems in multiple steps.
3. The focus group reviewed all PowerPoint slides for the course to ensure there were discussions of physical concepts that are most important in every chapter.
4. The course developer changed the instructor memo for the course and required instructors emphasize the process of solving problems that starts with getting all of the variables identified, the values of the known variables and how to solve literal equations for the unknown variable. At that point it is relatively straight forward process to substitute the know values for variables and solving for the value of the unknown variable. Instructors need to remind students NOT to round off values during intermediate steps when solving problems. Also added specific emphasis on students reading and downloading students' hints for success and a guide to help them use the correct units when entering solutions to problems.

Many students were losing points in homework and on exams by using inappropriate units.

5. The course developer specifically asked instructors to direct students to the videos that show students how to solve physics problems.
6. In February 2009 we reorganized the online PHYS 102 course to reduce the amount of work in the early modules and spread the work more evenly throughout the course. We also provided instructors an assessment of what physics concepts the students needed to work on based on assessment data. Finally, we reorganized the PHYS 102 course outline to provide instructors a schedule of activities from the online course that can be adapted to delivering the course in the classroom
7. The course developer changed the wording of select problems that caused confusion when read by the instructors and students alike. The rewording of the problems does not change the assessment of learning, but rather clarifies the problem to be solved. Finally, we added hints to other select problems that should help the student reflect on what they learned in the formative activities such as the homework and discussion board problems.

Results of Assessing Student Learning After Making Changes to the Course

In the spring of 2009, we collected data from the summative exam completed by students in four online sections. The detailed data are available in Appendix A and a comparison of the content results fall 2008 versus spring 2009 sections is shown in Figure 3.

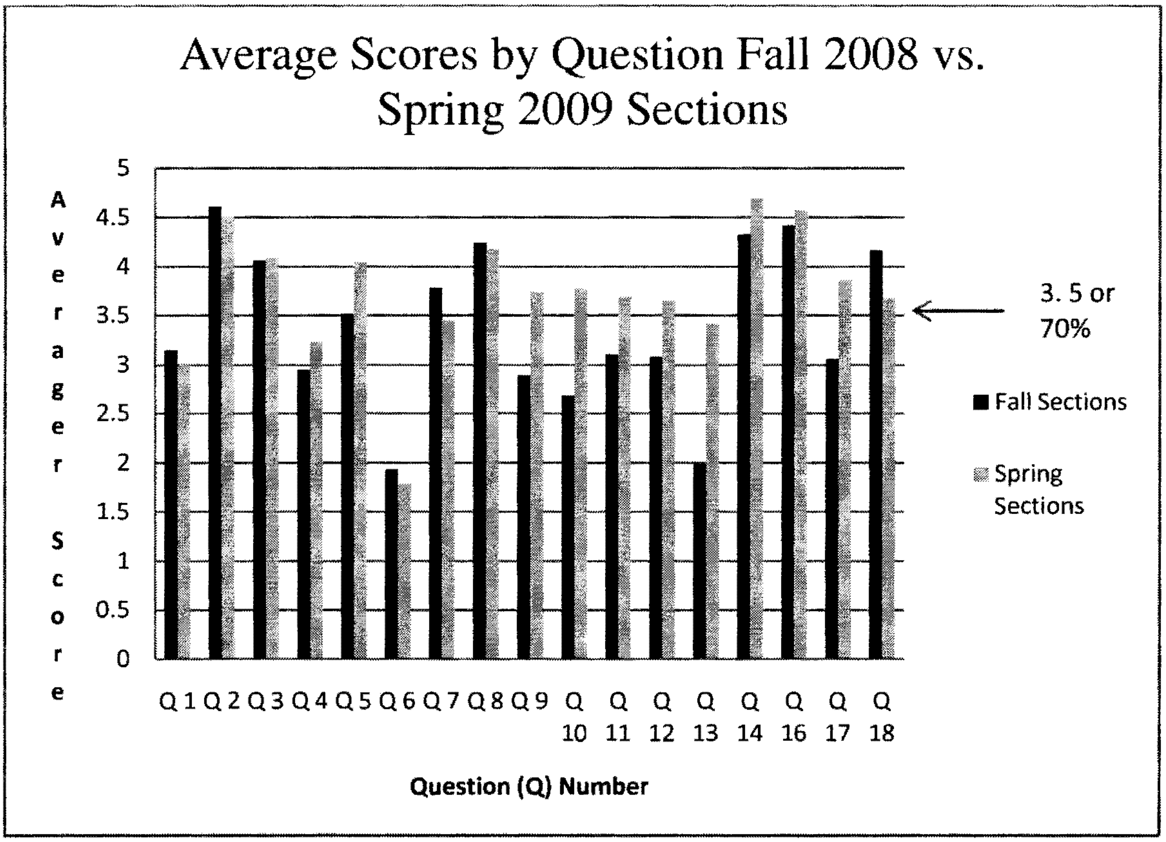

Figure 3. Average scores on the first summative assessment by question number.

Discussion of Results and Conclusions

Evaluating Results of the Overall Goal for Assessing Student Learning Fall 2008 Versus Spring 2009

The data show that the fall sections had an average grade of 74.64, while the spring sections that had an average grade of 75.62. Although there is evidence of very slight improvement in the average grade for the assessment during the spring of 2009, the difference is not statistically significant. Neither the fall nor the spring data indicate that the students attained the overall goal that 90% of the students would receive a grade of 80 or above on the exam. Nevertheless, as the Nichols indicates in their book that:

> Whether the criteria established are higher than might otherwise be considered reasonable or lower makes little difference. Those faculty/staff groups setting their criteria higher than is actually realistic are free to change them once they have reviewed the actual assessment data (p. 120).

The author will convene the focus group of instructors to review the results of this study and discuss a more reasonable overall assessment goal for the program in the future.

Evaluating Results of the Content Goal for Assessing Student Learning Fall 2008 Versus Spring 2009

The data extracted from attempt statistics in the fall of 2008 sections show that the content goal (no single question would have an average score of less than 70%) was not attained for questions 1, 4, 6, 9, 10, 11, 12, 13 and 17 of the assessment. The data extracted from attempt statistics in the spring of 2009 sections show that the content goal (no single question would have an average score of less than 70%) was not attained for questions 1, 4, 6, 7, and 13 of the assessment. Thus we see a decrease in performance for question 7 that went from 76% in the fall to 69% in the spring. Based on a t-test of two independent sample means with a small sample, the t-test reveals that the difference in question 7 is not significant at the level of significance of $\alpha = 0.10$. However, we see an improvement in performance for questions 9 (58% to 75%), 10 (54% to 75%), 11 (62% to 74%), 12 (62% to 73%) and 17 (61% to 77%). Based on a t-test of two independent sample means with a small sample, the improvement is significant at a level of significance of $\alpha = 0.10$.

Conclusions and Recommendations

The LMS in Blackboard is a valuable tool that can be used to directly assess student learning associated with course learning outcomes that in turn map to program outcomes. The test manager allows the instructor to provide a variety of questions in various formats to test student learning. Once the assessment is completed, the Grade Center in Blackboard contains the statistical information needed to compare results between selected sections of a course. These attributes of Blackboard become even more valuable when using assessment data to determine how to improve student learning. It is the experience of the author that engaging a focus group of instructors routinely teaching the course online or in the classroom when reviewing assessment results and making recommendations for improvement works well. By having more experts reviewing data, mulling over the results and making recommendations for improvement, you end up with better results from the process.

The results from this test of a process are not conclusive, but do indicate that the process can be used to improve student learning. There are many variables that may cause the results to vary from what the author experienced. Student attitudes toward learning play a crucial role in the success of any assessment program. The attitude of instructors teaching the course sections also plays a key role then trying to improve student learning. If either group decides to give less than their best efforts, making changes to a course may not produce the results desired. The author believes we need to constantly engage instructors and students alike at the beginning of a course to make sure they are up to giving their best efforts.

Although we should not use the results of the statistical analysis to infer the changes made to the course definitively improved student learning, we can see that by engaging instructors in a discussion of how to improve student learning did result in measureable improvement in some cases. It remains to be seen whether a more systematic sampling of data from sections of the online course over the period of a year would produce similar results. The author plans to undertake such a statistically significant sampling in the future.

Anecdotal Evidence of Improved Student Learning in a Classroom Environment

The author taught PHYS 102 in the classroom during the January – March 2009 term. He used all of the content from the PHYS 102 online course, but delivered the content face-to-face in the classroom. In this situation, the students in the classroom had an advantage over students taking the course online, since they engaged the instructor in face-to-face discussions of the content, learned to work problems with the benefit of seeing the process first hand and worked one-on-one with the instructor when they were struggling with the course. The students in the classroom completed the same graded activities that online students were responsible for and took the same summative exam under the same constraints that online students experienced. The results from the assessment in the classroom were compared to the overall and content goals in the same manner as for the assessment of the online sections. The results, listed below, reveal that student performance in the classroom environment appears to be somewhat better than student performance in the online sections.

In the classroom, 11 out of 16 students or 69% received a grade of 80 or above on the exam compared to 48% of student in the online sections. Figure 4 shows a comparison of average scores by question number for the online and classroom sections.

PHYS 102 First Summative Exam Results Fall 2008 Content Assessment Goal Online versus Classroom Sections						
	Section 1	Section 2	Section 3	Section 4	Classroom	
Student Count	17	14	13	17	16	Average Online Sections
Average Grade	72.15	80.93	64.96	80.53	80.30	74.64
Median Grade	75.00	87.00	61.5	80.00	83.25	
Scores by Question						
Q 1	3.35	3.93	2.65	2.66	3.53	3.15
Q 2	4.91	4.13	5.00	4.38	4.94	4.61
Q 3	4.21	4.37	3.81	3.84	4.56	4.06
Q 4	2.91	4.10	2.08	2.69	3.59	2.95
Q 5	3.15	4.63	3.00	3.25	4.03	3.51
Q 6	2.03	3.30	1.35	1.03	2.97	1.93
Q 7	4.26	4.23	3.31	3.31	4.09	3.78
Q 8	4.21	4.53	4.46	3.75	4.59	4.24
Q 9	3.32	3.50	2.62	2.13	3.14	2.89
Q 10	2.85	3.57	2.15	2.16	3.75	2.68
Q 11	2.68	3.77	3.08	2.91	3.41	3.11
Q 12	3.06	3.20	3.38	2.69	3.69	3.08
Q 13	2.94	3.93	1.08	0.00	4.00	1.99
Q 14	4.71	3.67	4.23	4.69	5.00	4.33
Q 15	8.76	8.60	8.54	9.00	8.88	8.73
Q 16	4.41	4.20	4.38	4.69	5.00	4.42
Q 17	3.38	2.60	3.46	2.81	4.38	3.06
Q 18	4.29	4.47	3.85	4.06	4.31	4.17

Figure 4. Average scores on the first summative assessment by question number.

The data in Figure 4 show that student performance in the classroom was in general better than student performance in the online sections. In the classroom, the student performance exceeded the content goal for all questions except questions 6 and 9, whereas the student performance in the online sections did not exceed the content goal for questions 1, 4, 6, 9, 10, 11, 12, 13 and 17.

The author attributes the improved performance to the fact that students were able to work one-on-one with the instructor in the classroom on a weekly basis. In those sessions, the instructor was able to talk the student through the problem solving process, helping the students understand where they were making mistakes in the process. In addition, in the classroom the instructor was able to react to the typical student question in a physics course "How did you get from here to there?" The author believes that using EagleVision in conjunction with an online course to conduct problem solving sessions with students would result in improved student problem solving skills. In fact, the author plans to use EagleVision to conduct problem solving sessions with online students the next time he is scheduled to teach the course online.

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Appendix A

Summary of Results from Direct Assessment of Student Learning In PHYS 102

PHYS 102 First Summative Exam Assessment Results October 2008 Overall Assessment Goal					
	Section 1	Section 2	Section 3	Section 4	Average All Sections
Student Count	17	14	13	17	
Average Grade	72.15	80.93	64.96	80.53	74.64
Median Grade	75.00	87.00	61.50	80.00	
Grades by Student					
Student 1	75.0	87.0	47.0	83.0	
Student 2	91.5	90.0	90.0	77.0	
Student 3	71.5	72.0	49.0	92.0	
Student 4	39.0	92.0	65.0	80.0	
Student 5	84.0	94.0	50.5	75.0	
Student 6	76.5	87.0	84.0	90.0	
Student 7	63.5	65.0	53.0	73.0	
Student 8	47.5	90.0	39.0	85.0	
Student 9	81.0	70.0	87.0	90.0	
Student 10	70.5	99.0	89.0	88.0	
Student 11	81.5	90.0	84.5	78.0	
Student 12	72.5	62.0	45.0	70.0	
Student 13	84.0	65.0	61.5	70.0	
Student 14	86.5	70.0		80.0	
Student 15	53.5			78.0	
Student 16	60.0			74.0	
Student 17	88.5			86.0	
Grades ≥80	7	8	5	9	29
% Grades >80	41%	57%	38%	53%	48%

PHYS 102 First Summative Exam Assessment Results Fall 2008 Content Assessment Goal						
	Section 1	Section 2	Section 3	Section 4		
Student Count	17	14	13	17	Average All Sections	
Average Grade	72.15	80.93	64.96	80.53	74.64	
Median Grade	75.00	87.00	61.5	80.00		
Scores by Question					Average All Sections	
Q 1	3.35	3.93	2.65	2.66	3.15	[redacted]
Q 2	4.91	4.13	5.00	4.38	4.61	92%
Q 3	4.21	4.37	3.81	3.84	4.06	81%
Q 4	2.91	4.10	2.08	2.69	2.95	[redacted]
Q 5	3.15	4.63	3.00	3.25	3.51	70%
Q 6	2.03	3.30	1.35	1.03	1.93	[redacted]
Q 7	4.26	4.23	3.31	3.31	3.78	76%
Q 8	4.21	4.53	4.46	3.75	4.24	85%
Q 9	3.32	3.50	2.62	2.13	2.89	[redacted]
Q 10	2.85	3.57	2.15	2.16	2.68	[redacted]
Q 11	2.68	3.77	3.08	2.91	3.11	[redacted]
Q 12	3.06	3.20	3.38	2.69	3.08	[redacted]
Q 13	2.94	3.93	1.08	0.00	1.99	[redacted]
Q 14	4.71	3.67	4.23	4.69	4.33	87%
Q 15	8.76	8.60	8.54	9.00	8.73	87%
Q 16	4.41	4.20	4.38	4.69	4.42	88%
Q 17	3.38	2.60	3.46	2.81	3.06	[redacted]
Q 18	4.29	4.47	3.85	4.06	4.17	83%

PHYS 102 First Summative Exam Results Follow-up Spring 2009 Overall Assessment Goal					
	Section 1	Section 2	Section 3	Section 4	
Student Count	17	19	19	12	Average All Sections
Average Grade	79.94	73.79	73.79	74.96	75.62
Median Grade	82.00	76.00	76.50	79.75	
Grades by Student					
Student 1	75.0	59.0	87.0	80.5	
Student 2	84.0	77.5	61.0	47.0	
Student 3	58.0	61.5	74.0	79.0	
Student 4	82.0	79.5	95.5	91.5	
Student 5	75.0	76.0	45.5	88.0	
Student 6	98.0	81.0	56.0	64.5	
Student 7	51.0	59.5	82.5	91.5	
Student 8	98.0	80.5	88.5	59.5	
Student 9	79.0	87.5	94.5	80.5	
Student 10	88.0	67.0	65.5	81.5	
Student 11	83.0	69.5	81.0	72.5	
Student 12	79.0	89.0	54.5	63.5	
Student 13	48.0	72.0	76.5		
Student 14	89.0	80.5	78.0		
Student 15	94.0	89.0	82.5		
Student 16	79.0	46.5	64.5		
Student 17		83.0	93.0		
Student 18		69.5	58.5		
Student 19		74.0	63.5		
	8	7	8	6	29
	53%	42%	42%	50%	43%

PHYS 102 First Summative Exam Results Follow-up Spring 2009 Content Assessment Goal						
	Section 1	Section 2	Section 3	Section 4		
Student Count	17	19	19	12	Average All Sections	
Average Grade	79.94	73.79	73.79	75.50	75.76	
Median Grade	80.50	76.00	76.5	80.50		
Scores by Question					Average All Sections	Percentage of Possible Points
Q 1	3.44	3.53	3.16	1.88	3.00	[redacted]
Q 2	4.25	4.68	4.47	4.63	4.51	90%
Q 3	4.25	4.03	4.21	3.88	4.09	82%
Q 4	3.19	2.82	3.03	3.88	3.23	[redacted]
Q 5	4.13	4.50	4.03	3.50	4.04	81%
Q 6	3.10	0.84	1.58	1.58	1.78	[redacted]
Q 7	3.59	3.34	3.74	3.13	3.45	[redacted]
Q 8	4.88	3.42	4.68	3.75	4.18	84%
Q 9	3.81	3.34	3.24	4.58	3.74	75%
Q 10	3.63	3.84	3.76	3.83	3.77	75%
Q 11	4.13	3.13	3.24	4.25	3.69	74%
Q 12	3.50	3.47	3.63	4.00	3.65	73%
Q 13	4.56	3.95	3.47	1.67	3.41	[redacted]
Q 14	3.75	5.00	5.00	5.00	4.69	94%
Q 15	8.81	8.68	9.26	9.42	9.04	90%
Q 16	4.06	5.00	4.21	5.00	4.57	91%
Q 17	3.44	3.95	3.45	4.58	3.86	77%
Q 18	4.88	3.21	2.89	3.75	3.68	74%

Appendix B

Educational Program Outcome Report for PHYS 102

ASSESSMENT RECORD FOR

Educational Program Outcome

Physical and life Sciences

Degree Levels Supported:

Associate and Bachelor

Assessment Period: 2008 - 2009

Report Date: March 1, 2009 (updated April 2009; updated July 2009)

Intended Educational (Student Learning) Program Outcome:

Note: Prepare one page for each intended outcome listed on the Assessment Linkage Page. Enter the number of the intended student outcome and copy the outcome here.

Intended Educational Program Outcome PO 1: Apply knowledge of college level mathematics to defining and solving problems.

Assessment Method and Criteria for Success:

Method of Program Assessment: Deploy a 15 - 20 question/problem exam that tests the students' understanding of physical principles from the first three very important chapters covered in PHYS 102. Select several sections of PHYS 102 being taught online and at campuses in October 2008, deploy the exam, gather the data on student performance and analyze the data to determine whether students demonstrate an acceptable understanding of the concepts being tested. The exam will address Learning Outcomes 1 & 2 in the PHYS 102 course outline.
Criteria for Success: Set an overall goal of 90% of the students achieving 80% or higher on the assessment exam. Set a content goal that no item on the exam will have a score of less than 70% of the points available on the exam.
Assessment Data Collected: There were four section of PHYS 102 Online with a total of 61 students who completed the exam (Section 1: 17 students; Section 2: 14 students;

Section 3: 13 students; Section 4: 17 students). There was one section of PHYS 102 in the classroom with 16 students who completed the first exam. There was one section of PHYS 102 students in the classroom who were taking an accelerated version of the course on weekends with only four students. We did not include the results of the four students in the accelerated course since it was apparent that they were not very well prepared for the exam and will be addressed separately in this report.

Analysis of Assessment Data:

We had an overall goal of 90% of the students achieving 80% or higher on the assessment exam.
Of the 77 students both online and in the classroom who completed the exam, only 40 out of 77 (52%) scored a grade of 80 or higher on the exam. The Online section that had the highest percentage of exam grades > 80 was Section 2, with 57% of the students exceeding the overall criterion of 80%. The on ground class had 69% of the students exceeding the criterion of > 80% on the exam. It appears from preliminary results that students in the classroom who have the benefit of an instructor in a face-to-face learning environment seemed to do better on the exam. . Perhaps we need to look at what an appropriate overall goal should be for this assessment. The average grade on the exam for all sections was 75.77 with a median grade of 80. We may want to consider an overall goal of an average grade or use the median as a goal.

We set a content goal that no item on the exam will have a score of less than 70% of the points available on the exam. The results for the following questions indicated that students' responses to the questions did not result in a score high enough to achieve the content goal.

Question 1: The catapult on an aircraft carrier can take an aircraft from 0 to [v] mph in [t] seconds, at which time the aircraft launches. Express the velocity in SI units (mks system). Average score on this question was 3.22 out of 5 for a score of 64%. The problem required the student to convert the velocity in mph to m/s before proceeding to solve the problem. The students in the on ground class scored 70.6 and one section of the online classes scored 78.6 on the problem. We may want to reword the problem to read "Express the velocity in meters per second."

Question 3: An aircraft weighing [W] N is accelerated at [a] m/s/s for 5 seconds, at which time the aircraft launches. Assume the acceleration is constant. What is the force required to launch the aircraft? Average score on this question was 3.07 out of 5 for a score of 61%. The problem required the student to convert the weight to mass before proceeding to solve the problem for the force (Force = mass x acceleration). The students in the on ground class scored 71.8 and one section of the online classes scored 82 on the problem. . We need to reinforce the process of solving a problem in multiple steps by emphasizing examples of the process.

Question 6: An aircraft weighing [W] N is accelerated at [a] m/s/s for [t] seconds, at which time the aircraft launches. How much work was done on the aircraft? The acceleration is constant. Average score on this question was 2.14 out of 5 for a score of 43%. The problem required the student to convert the weight to mass (similar to Question 3) before proceeding to solve for the force (Force = mass x acceleration). Then the student needed to recognize there is another intermediate step in solving the problem. The student needed to use the acceleration and time information to determine the distance ($d = \frac{1}{2} at^2$) over which the force is applied in order to solve for work = force x distance. The students in the on ground class scored 71.8 and one section of the online classes scored 82 on the problem. It appears that we need to work on students solving multiple step problems in the course. In this case it is a three step process. We need to reinforce the process of solving a problem in multiple steps by emphasizing examples of the process

Question 9: A [m] kg satellite is in a circular orbit of 26,273 miles (42,300,000 m) in radius. The force keeping the satellite in orbit is [F] N. What is the velocity of the satellite? Average score on this question was 2.94 out of 5 for a score of 59%. The problem required a student to solve the equation $F = mv^2/r$ for the variable $v = \sqrt{\frac{Fr}{m}}$. This solution is one of the more complex derivations in the first part of the course. Only one online section attained the goal. We need to reinforce the process of solving a literal problem for an unknown variable in multiple steps by emphasizing examples of the process. There are examples of similar problems in the PowerPoint slide in the online course and the same slides can be used in courses being offered in a classroom face to face.

Question 10: A [m] kg bullet traveling at [v] m/s hits a [M] kg block of wood and stays in the wood. What is the velocity of the wood block immediately after the bullet hits it? Average score on this question was 2.90 out of 5 for a score of 58%. This is a conservation of momentum problem and there is an example of the problem in the PowerPoint slides for Chapter 3 and a similar problem in the examples within Chapter 3 that deals with a collision of automobiles instead of a bullet and block of wood. Students should have done better on this problem. One online section and the on ground class attained the goal. We need to reinforce the process of solving a literal problem for an unknown variable in multiple steps by emphasizing examples of the process. There are examples of similar problems in the PowerPoint slide in the online course and the same slides can be used in courses being offered in a classroom face to face.

Question 11: It takes an elevator [t] minutes to raise a vehicle with a mass of [m] kg from the floor to a height of [d] meters. What size (power) motor (in watts) does it take to do the job? Average score on this question was 3.17 out of 5 for a score of 63%. In this problem the student must convert minutes to seconds before proceeding with the problem solution. Power = work/time (in seconds) = (F x d)/t = (mgd)/t. If the student breaks the problem down into components the solution is rather straight forward. Since the acceleration due to gravity (g) is not specifically given, some students may not have recognized the solution and the fact that they have to convert minutes to seconds complicates the solution. One online section attained the goal and the on ground class came very close (68.2%). We need to reinforce the process of solving a multiple step problems for an unknown variable by emphasizing examples of the process. Ensure there are examples of similar problems in the PowerPoint slide in the online course and the same slides can be used in courses being offered in a classroom face to face.

Question 12: Match the given type of motion with the nature of the net force producing the motion. Average score on this question was 3.20 out of 5 for a score of 64%. The on ground section attained the goal. We need to reinforce the concepts of force and motion associated with Newton's Laws. Ensure there are examples of the concepts in the PowerPoint slide in the online course and the same slides can be used in courses being offered in a classroom face to face.

Question 13: As a rocket is launched, its acceleration increases but the net force on it stays constant. Explain what causes this increase. Average score on this question was 2.39 out of 5 for a score of 48%. This question is an essay question graded by the instructor. One online section and the on ground class attained the goal. In Chapter 3 ensure the instructor addresses the concept of conservation of mass and energy as applies to Newton's Second Law; F = ma where F is constant and mass decreases.

Question 17: You find a 20 N box on the middle of a set of stairs and carry the box up a flight of stairs to a deck, raising its elevation by 5 m. Then you drop the box off of the deck. As the box reaches its original level (the box is moving when it reaches the original level because it has not reached the ground), its kinetic energy is: (this is a multiple choice question). Average score on this question was 3.33 out of 5 for a score of 67%. The on ground section attained the goal and one online section came close (68%). Emphasize the example in the textbook that deals with the conservation of total energy = KE + PE. The discussion in the text associated with Figure 3.27 demonstrates the concept.

Change Instituted as a Result of Assessment to Improve Student Learning:

8. After we launched a reorganization of the PHYS 102 online course in February 2009, we held a teleconference with several physics instructors who had taught the course recently to review the analysis of the data collected and as a team make recommendations to improve student learning in the course. The recommendations of the instructors have been incorporated in the updated version of this report.
9. Reviewed all PowerPoint slides for the course and added examples of problems that demonstrate how to solve physics problems in multiple steps.
10. Reviewed all PowerPoint slides for the course and ensured there were discussions of physical concepts that are most important in every chapter.

11. Changed the instructor memo for the course and required instructors emphasize the process of solving problems that starts with getting all of the variables identified, the values of the known variables and how to solve literal equations for the unknown variable. At that point it is relatively straight forward process to substitute the know values for variables and solving for the value of the unknown variable. Instructors need to remind students NOT to round off values during intermediate steps when solving problems. Also added specific emphasis on students reading and downloading students' hints for success and a guide to help them use the correct units when entering solutions to problems. Many students were losing points in homework and on exams by using inappropriate units.
12. Specifically asked instructors to direct students to the videos that show students how to solve physics problems.
13. In February 2009 we reorganized the online PHYS 102 course to reduce the amount of work in the early modules and spread the work more evenly throughout the course. We also provided instructors an assessment of what physics concepts the students needed to work on based on assessment data. Finally, we reorganized the PHYS 102 course outline to provide instructors a schedule of activities from the online course that can be adapted to delivering the course in the classroom.
14. Changed the wording of select problems that caused confusion when read by the instructors and students alike. The rewording of the problems does not change the assessment of learning, but rather clarifies the problem to be solved. Finally, we added hints to other select problems that should help the student reflect on what they learned in the formative activities such as the homework and discussion board problems.

Changes made to select questions in the summative exam for PHYS 102 online.

Question 1: The catapult on an aircraft carrier can take an aircraft from 0 to [v] mph in [t] seconds, at which time the aircraft launches. Express the speed of the aircraft when it is launched in BASIC SI units (not km/hr).

Question 4: An aircraft weighing [W] N is accelerated at [a] m/s/s for 5 seconds, at which time the aircraft launches. Assume the acceleration is constant. What is the force required to launch the aircraft? Hint: this is a multiple step problem in which you must derive the variables needed in Newton's equation for force.

Question 6: An aircraft weighing [W] N is accelerated at [a] m/s/s for [t] seconds, at which time the aircraft launches. How much work was done on the aircraft? The acceleration is constant. Hint: this is a multiple step problem in which you must derive the variables needed to solve for problem in step one and then apply those values to the final solution of the problem.

Question 7: When an aircraft returns to the aircraft carrier and lands, it goes from [v] mph to 0 mph in [t] seconds. What is the acceleration in this case (in m/s/s)? CAUTION: Think about what is happening in a physical sense and that it matches your answer.

Question 9: A [m] kg satellite is in a circular orbit of 26,273 miles (42,300,000 m) in radius. The force keeping the satellite in orbit is [F] N. What is the velocity of the satellite?

Question 11: It takes an elevator [t] minutes to raise a vehicle with a mass of [m] kg from the floor to a height of [d] meters. What size (power) motor (in watts) does it take to do the job? Hint: this is a multiple step problem in which you must have the correct units and derive the variables needed to solve for problem in step one and then apply those values to the final solution of the problem.

Question 13: As a rocket is launched, its acceleration increases but the net force on it stays constant. By using Newton's second law of motion, explain what cause of this increase.

Note to instructors: Discuss Newton's Second Law of motion $F = ma$ and how the change in each variable, one by one, affects the values of the other variables.

Question 17: You find a 20 N box on the middle of a set of stairs and carry the box up a flight of stairs to a deck, raising its elevation by 5 m. Then you drop the box off of the deck. As the box reaches its original level (the box is moving when it reaches the original level because it has not reached the ground), its kinetic energy is

Note to instructors: Discuss the example of the basketball and PE/KE conversions that is in the textbook.