

ABET/ NAIT AND STUDENT LEARNING OUTCOMES SUMMARY

(See Reports in B.7.a.1 and 2; also, Professor Examples in B.7.b.1-5; also
Portfolio Section A.5

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Upon completing the overall course analysis, teaching models and styles analyses, the student learning style analyses, and the analyses for achieving the levels of Bloom's Taxonomy and Dale's Cone of Learning, the professors engaged on a new interactive path between continuing to analyze aspects of the 2005 course and beginning the redevelopment of the 2006 course for the experimental research semester.

Process for Developing the 2006 Course Outcomes

During the Student Learning Outcomes program component, the faculty members reconsidered their course from the student learning outcomes perspective. They each determined the ABET or NAIT standards or outcomes that were important for their courses and redeveloped student learning outcomes at the primary, second, and third levels of breakout. Once the outcomes were developed and written appropriately as outcomes oriented statements that were measurable and active, they put them into a chart format. In preparation for the chart, most of them first developed an outline-like document or "list." Not all professors were proficient at the American or English concept of "outlining" showing levels of content breakout. Some opted for a list approach to this activity. For the most part, the list worked to serve our needs, which was to reveal the complexity of the primary outcomes and break them out into second and third level outcomes so the professors would better understand the complexity of the content in the course. This process also served to reveal the embedded general education knowledge and skills expected of students (e.g. mathematics, science, and communications). And even though the program leader had already prepared the chart(such that the ABET and NAIT standards or outcomes revealed the embedded NIU general education goals written as outcomes), this was an important aspect of the redevelopment of the 2005 course outcomes. The process led the professors into a deeper understanding of the embedded content, whether second and third level engineering and technology knowledge and skills or general education, and they became much more aware of what they were expecting of students and trying to achieve with student learning. We accomplished this through a variety of processes: outlining, lists, matching, analysis, and mapping connections. The charts worked well to assist in the process and organize the professors' redevelopment of the 2005 course outcomes.

Once the student learning outcomes were developed and connected to the national standards or outcomes, ABET or NAIT, and the embedded general education knowledge and skills were identified, the professors analyzed their new student learning outcomes to determine which of Bloom's Knowledge Dimensions were represented by the course content (e.g. factual, conceptual, procedural, or meta-cognitive). They then analyzed the new outcomes to determine or confirm that the outcomes were written to achieve more of the upper levels of Bloom's Cognitive Process Dimension, using either the traditional or revised version (e.g., traditional: knowledge, comprehension, application, analysis, synthesis, and evaluate; revised: remember, understand, apply, analyze, evaluate, and

create). Finally, the professors analyzed the outcomes for level of active versus passive learning on Dale's Cone.

Performance

Transitioning from analysis of the 2005 courses to their redevelopment, we will now speak in terms of the development of the 2006 version of their 2005 courses. The professors performed extremely well in the development of the 2006 courses and the student learning outcomes that define the courses. The learning outcomes statements were expressed more appropriately with active verbs and as measurable outcomes and were more specific. The terminology served to more clearly present what was to be learned by the students, and the learning statements were more coherent. With the breakout of the primary statements into the second and third levels, it became much easier to understand what was to be accomplished in the courses and by students. Furthermore, the overt identification and mapping of the embedded general education outcomes clearly revealed the expectations related to the underlying mathematics, science, and communication foundations of the engineering and technology knowledge and skill content. Using Bloom's Knowledge and Cognitive models served to reveal and assure the professors that the outcomes statements were capable of formally achieving the upper cognitive levels and inherent higher levels of critical thinking. Identifying the content by Bloom's Knowledge Dimensions served to confirm that the content was addressing more than factual knowledge (i.e., lower levels of the Cognitive Process Dimension). They tried to more formally show that the four (facts, conceptual, procedural, and metacognitive knowledge) were represented in the student learning outcomes. The more knowledge dimensions represented in course content, the greater the possibilities for learning to achieve the higher levels of the cognitive process dimensions. This one aspect, however, was not accomplished as deeply as we would have preferred. The analysis related to Bloom's Knowledge Dimension needed more time and focus. However, most of the professors understood how it could help them analyze their content and improve its coverage if they included content from more of the knowledge dimensions, realizing that if they are addressing each of Bloom's Knowledge Dimensions, they are more likely to achieve the higher levels of Bloom's Cognitive Process Dimension more often. They became aware of the potential of the knowledge dimension, but during our process did not use it to its fullest power to improve the content of their courses. However, their course contents did reflect knowledge from across Bloom's knowledge dimensions; but it was documented as completely as possible. Finally, the professors determined whether each outcome was active, passive, or intermediately active on Dale's Cone of Learning. This assisted them to focus on the quality of learning through purposeful constructivism, where the burden of learning to build knowledge and skills through accomplishing real world tasks is on the student, going beyond the more abstract memorization and limited comprehension levels to being able to use knowledge, manipulate it, extend it through problem based learning and across different learning contexts. The professors tried to build scaffolding into the learning process to increase depth and understanding through increased ability to use knowledge and skills being learned while also engaged in learning.

Results

Overall, the 2006 courses have greatly improved student learning outcomes that will engage students in learning more actively at the upper levels of Bloom's Cognitive Process Dimension. The professors are also cognizant of Bloom's Knowledge Dimensions and that they should strive to address the four types of knowledge with particular purpose. They did check that the knowledge and skills, etc. represented in the student learning outcomes crossed the four knowledge dimensions. However, they could have used more time to focus on this aspect of our program. The professors benefited from using Dale's Cone to gauge the quality of active learning. Ultimately, Bloom and Dale's models have become informal and formal metrics for continuous improvement of the courses, teaching, assessments, and student learning. The professors have a much deeper understanding of what outcomes statements should achieve, their connection to the ABET and NAIT standards and outcomes, their relationship to the embedded general education goals, and that they are written to lead students to "knowing about," "knowing," or "being able to "do" or perform." They also better understand what active or engaged learning means and that if they are to lead students to "using" knowledge and skills, then active learning involves creating a different type of learning environment: one that is inquiry and discovery driven and one that goes beyond "problem solving" to problem based learning where students have the opportunity to perform real world tasks using their knowledge and skills and where expectations for performance are clearly understood by professors and students because there are clear and well defined performance standards and criteria. They understand how to use the Bloom's models to analyze and develop their courses. Of great importance is that professors now see the embedded general education outcomes as more than prerequisites or foundations for learning the engineering and technology content. The professors now better understand that the engineering and technology learning context and content continues, extends, deepens, and expands the learning of general education knowledge and skills and, ultimately, that they are responsible for continuing the learning of mathematics, science, and communication at higher levels in the engineering and technology contexts. That is a very different viewpoint and understanding. The following data tables support that conclusion.

In summary, the outcomes can continue to improve and be refined, but the learning, demonstrated by the professors through their 2005 outcomes analyses and newly developed 2006 outcomes, which were greatly improved, revealed their deeper understanding and ability to make course content decisions and to use a stronger theoretical basis for making those decisions. They have the knowledge and skill to continue this process from this point forward, as they have clearly demonstrated their significant gain in knowledge, skills, and ability regarding the development of student learning outcomes. The Outcomes program component led to the Student Assessment program component.

See Copy of Section B.5.b GAPS Analysis (Discussion of Student Learning Outcomes) Below

GAPS ANALYSIS SUMMARY (FALL 2005 AND FALL 2006)

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Student Learning Statements (Outcomes)

In the initial analysis of the Fall 2005 courses – where we began, professors used their existing course syllabi. Although as a college, we had improved our student learning statements during the accreditation process, they remained rather unorganized and weak in content and appropriate expression. The learning statements were expressed in mixed modes across syllabi. Some learning statements were written as course objectives; others were written as student learning objectives; yet others were written as more outcome-oriented statements. However, in generalizing, many and sometimes most of the student learning statement formats across syllabi were not active, clear, measurable, or clearly outcomes-oriented, where the professor and student could ascertain exactly what was expected and would be measured, and/or determine the culminating grade. Three professors expressed the learning statements in a way where students could see that there was a relationship between student learning outcomes and the ABET or NAIT outcomes, but if the ABET or NAIT outcomes were identified by a letter and not stated, then the relationship was not clear nor were students about to review the accreditation outcomes for their own information. Two professors expressed the statements more clearly, with written statements for both the national standards and the learning outcomes for the course. The other five professors did not show the national statements in narrative but rather identified them by letter or number, regarding the level of coverage and depth of relationship. This had little meaning for students and did not make it easy for the professors to clearly be assured of direct links and relationships. Generally, the statements did link to the ABET or NAIT standards or outcomes, but often not clearly or strongly. It would have been difficult to determine a direct link, especially in light of the student learning assessments being used for the 2005 course. Therefore, we examined the 2005 syllabi and course content related to the standards as well as we could, with the understanding that the student learning outcomes to be redeveloped would better and more clearly and directly link to the national standards and assessments – a two-way link revealing the critical knowledge and skill connections.

Below are two charts that broadly identify the standards addressed in the Fall 2005 courses, according to the content and syllabus analysis by each professor of his/her course. The data are presented (in black) as collapsed across either all engineering professors or engineering technology professors as a broad viewpoint. The **Fall 2006** courses are presented in red, and although there are minor differences in the number of standards addressed, there is a great and very significant difference in the quality of the learning statements and their direct links to both the national standards and the learning assessments. The tables also reflect the number of learning outcomes for each standard by professor, **2005-2006** when possible. For the **2006** courses, the professors not only have improved wording and expression, but the knowledge and skill connections are much stronger. In addition, the outcome statements are improved because they are broken out into primary, second, and third level statements. The quality is improved not only because of better wording, but also because they now better understand the difference between complex statements, where there is a cluster of outcomes inherent to a single

primary outcome statement. Thus the course content or the knowledge and skills to be taught became more obvious in the inherent breakouts of second and sometimes third level outcomes. This provided insight and assisted the professors in understanding what underlying or inherent knowledge and skills were required for a complex cluster of difficult primary learning outcomes – in other words, the knowledge and skills inherent to a single complex primary outcome. Therefore, readers may be amazed at the number of changes that resulted.

Usually, the primary statements would be used on syllabi or other reporting documents, but the analysis and breakout of second or third level learning statements provided a great learning experience for professors and led them to design and then engage students in more intentional, thoughtful, and higher quality learning experiences. This analysis and process can lead to more astute teaching and student learning, student assessments, instructional choices, learning process decisions, and more. Remember, each course is not required to address every national standard or outcome, but instead the standards or outcomes of focus selected should be addressed well. It is important that the professors understand individual course versus program requirements, that there is a cumulative effect across courses for the entire program and that the overall program is required to address all national standards or outcomes, not any single course; therefore, many standards will be addressed across multiple courses. However, particular standards may be addressed in only one or two courses across the program, depending on content, depth, program level, (e.g., introductory or capstone course). Professors sometimes mistakenly strive to address all or too many outcomes; thus the course content can become weak or superficial. Finally, when identifying the objectives or outcomes listed below, an * is used where one objective or outcome covers more than one ABET outcome or NAIT standard or where there is a greater total of “1s” than the total in the number in parentheses (4). The determining factor is the level of coverage of content.

Regarding outcomes, it is important to note that the professors analyzed the engineering or technology course content for embedded NIU General Education Goals. This analysis led them to more deeply understand why students fail to perform well in their courses if they do not come to the course with the appropriate general education knowledge and skills that are the underlying foundation for the engineering and technology content. The program leader revealed the strong relationships between NIU General Education Goals (outcomes) and the ABET and NAIT standards or outcomes by aligning and inserting them into a worksheet. That made it much easier and more efficient for the professors to see the direct relationships, to consider the importance of acknowledging the embedded general education goals/outcomes as part of their course content, and to realize that even though they are teaching engineering or technology courses, they are actually concurrently continuing, extending, expanding, and deepening the learning of general education content in the context of engineering and technology. This was extremely important. Our professors intuitively knew this but had never “studied” the connections, mapped the connections, or included the general educational goals aligned beside their engineering or technology outcomes. They had also never thought of themselves as continuing the learning of the general education knowledge and skills in engineering and technology content. They considered the general education math, science, and

communication knowledge and skills as prerequisites and only dealt with them when students did not have the knowledge or skills needed to perform on the engineering and technology content. Now the professors understand that they actually continue the learning of the mathematics, science, communication, etc. content in the engineering and technology context. The chart below reflects the 2005 course in black and the changes for the **2006** course in red. The professors improved the outcomes and connections and are committed to greater depth of change for the future. This was a very successful program component, resulting in significant learning and change.

Assumptions

Beware of assumptions when scanning the chart below and noting that one or more course outcome numbers did not seem to change. For example, one professor's number of outcomes did not change from 2005-2006; however, the quality of the outcomes for 2006 was very significantly different and improved. Also that professor's four primary outcomes were broken out into second and third level outcomes. Again, for example, one primary outcome inherently encompassed five secondary outcomes, with each of those broken out into a third level. Thus, the quality in content, linkages, and assessments was dramatically different and greatly improved for most of the courses.

Table B.7.1: Standards ABET-Engineering Outcomes (Fall 2005 and Fall 2006 courses) (5 engineering professors)

a. apply math, science, engineering	b. design/ conduct experiments; analyze, interpret data	c. design system, component, process-given constraints, etc.	d. function on inter-disciplinary teams	e. identify, formulate, solve engineering problems	f. understand professional, ethical responsibility	g. ability to communicate effectively	h. understand impact eng. Solutions on global, economic, environment, society	i. recognition of need for, and ability to engage in life-long learning	j. knowledge in contemporary issues	k. ability to use techniques, skills, and modern engineering tools
Fall 2005 and Fall 2006 Courses – ABET Outcomes										
5 +	2+ 1partial (no DOE) 1 NR 1 c	4 + 1+partial (could do lots more) 1 c	1+ 1 NR 3 c	4+ 1c	1+ 1+ (written reports only) 1 NR 2c	1+ 1 3c	1+ 1 NR 2c 1c (minor)	2+ 1+ (to small effect) 2c	4+ 1c	4+ 1+ (students don't use unless asked to)
5+	2+	4+	2+	5+	None	3+	1+	2+	4+	5+
(6-11) 1 - 4	1 - 1	1 - 2	1 - 1	* - 8		1 - 1	1 - none	* - none	* - 2	* - 3
(3/6--5) 1-5		1 - 1		1 - 5				* - 1	* - 1	1 - 1
(4-4) 1 - 1	* - none	1 - none	* - none	1 - 1	* - none	* - 1	*	*	*	1 - 1
(4-5) 1 - 5		1 - 5	3	1 - 5	* - none	1 - 3	* - none	* - 1	* - 1	1 - 2
(4-5) 1 - 2		1 - 1		1 - 1	* - none				1 - 1	1 - 1

Legend: + = yes-okay; c = need to consider; other notes

Table B.7.2: Standards ABET/TAC/NAIT-Engineering Technology & Industrial Technology
(2 engineering technology/technology professors) (Fall 2005 and Fall 2006 courses)

a. mastery of knowledge, techniques, skills, modern tools	b. ability to apply current knowledge; adapt to emerging applications of math, science, technology	c. ability to conduct, analyze, interpret experiments; apply experimental results to improve processes	d. ability to apply creativity in design of systems, components, processes	e. ability to function effectively on teams	f. ability to identify, analyze, solve technical problems	g. ability to communicate effectively writing	h. ability to communicate effectively orally	i. recognize need for, ability to engage in lifelong learning	j. ability to understand professional, ethical, social responsibilities	k. respect for diversity; knowledge of contemporary professional, societal, global issues	l. commit to quality, timeliness, continuous improvement	m. ability to program computers and/or use computer applications effectively	n. ability to use modern laboratory techniques, skills, equipment effectively	o. ability to manage projects effectively	p. ability to design, manipulate, manage industrial systems q. ability to manage or lead personnel effectively
Fall 2005 and Fall 2006 Courses – ABET/TAC/NAIT Outcomes															
2+	2+	1+	1+	1+	2+	1+	1+	1+	1+	1+	2+	2c	1+	1+	p. 1 no response 1c None
2+	2+	2+	2+	None	2+	2+	None	2+	1+ ? not sure	1+	1+	1+	1+	None	q. 1no response 1c None
(5-6) 1-6	1 - 5	1- 1	* - 1		1 - 4	6		* - 4	2	1	2	1	1 - 1		p. * -NR NR-NR
(6-19) 1-10	1 - 5	* - 5	* - 3		1 - 6	1		4	1-one	1	*-none			*-none	q. * -NR NR-NR

Legend: + = yes-okay; c = need to consider; other notes

Table B.7.3: NIU General Education Goals (Fall 2005 and Fall 2006) (7 professors across engineering and technology)

Writing	Speaking	Listening	Quantitative Reasoning	Use of Resources-Technology	Historical Development Of Culture	Significance of Arts	Cultural Traditions Philosophical Ideas	Methods in Science Methods in Social Science	Interrelatedness Across Disciplines	Social Responsibility Citizenship
C C+ Earlier it was only lab reports. In fall 06, they had to write reports for three PA tasks.	C C+ Presentation of PA tasks	+ + Listen to guest speaker, professor, fellow students during PA task presentations	+ C+ Homework, exams, PA tasks – all involved quantitative reasoning	+ + In addition to labs that required using many resources, had to use outside resources for PA tasks.	NR NA	NR NA	NR NA	NR NA	NR C May consider more interaction with EE for signal processing	NR C+ Discussed issues such as energy conservation, noise, pollution, ethics, etc.
C+ Did consider and add, still needs improvement; will keep working on it	C	?	C+ Strong, but could be better	+ I'm quite pleased	NA	NA	C-	C+	C	C
Ok + Project, exams, homework, using MS Word	C + Oral presentations with PowerPoint	C C- Lectures, case studies, discussion sessions	Ok + Material requires this	Ok + Software and computer to solve problems	NR NA	NR NA	NR NA	C NA	Ok, C+ Examples, exercises with topics from other disciplines	C C- Examples, exercises with topics from other disciplines
+ + PAs and homework	+ + Pas and discussion sessions	+ + Lectures, case studies, discussion sessions	+ + Problem solutions, homework, midterm and final exams	+ + PAs and homework	C NA	C NA	C NA	+ + Problem solutions, homework, midterm, final exams, and PAs	+ + Case studies and PAs	+ C- Case studies and PAs
C- + well addressed through PA reports	+ NA-possible to include for future course	C + lectures	+ + addressed in project design decisions	C + well addressed through project design decisions	NR NA	C + addressed through project design	NR - NA	C + well addressed through project design	C C+ to some extent when making design decisions	C C- possible to include for future courses
+ + Performance Tasks	+ + Group learning and interactions	+ + Group interactions	+ + Performance tasks, lab demonstrations	C NA	+ C+ Lectures	C + Lectures	+ C+ Lectures	+ NA? Lectures	C C+ Lectures	+ C+ Lectures
C +	C C- Lectures	C C- Lectures	+ N+ Lectures	+ + Lectures	+ NR	C NA	C NA	+ NA	C NA	C NA

Legend: + addressed well; NA-does not really apply in professor's opinion; C- do not do it, but still need to consider adding it in as professor continues to make changes; C+ did consider and add in; still needs improvement and professor will keep working to improve or add;