AC 2009-599: TEACHING FIRST-YEAR STUDENTS ANALYTICAL REASONING USING INTERDISCIPLINARY TEAMS

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Abstract

We argue in this paper for the formative value of general education to and for major-specific education within the public, state supported Agricultural and Technical University. In particular, we argue for the formative value of a first-year general education foundation course to the undergraduate Engineering curriculum. General education is often devalued by students as irrelevant and a waste of time. Students want major specific education, both because of their personal interests, and because of the perceived urgency to further their job and career goals. Major departments often want larger budgets which can result from high hours-requirements for their majors. Such desires can result in a correlative desire to take hours from general education in order to secure a larger share of the total possible hours for major hours. In addition, faculty members in major departments often deprecate general education as 'soft," unsophisticated, and intellectually and academically impoverished. We argue here for the positive value of general education. In particular, we argue for the positive value of a general education program centered on common foundation courses taken by all students at an institution. Even more particularly, we argue for the positive value of a foundation course, taken by all first- or second-year students, which introduces them to, and provides opportunities for them to practice, their critical, analytical, quantitative, and scientific reasoning skills. Most particularly, we argue for the positive value of such a course for undergraduate Engineering majors. In part one of our paper, we will correlate the goals, objectives, and curriculum of UNST 130 *Analytical Reasoning*, a general education foundation course at North Carolina Agricultural and Technical State University with specific undergraduate Engineering major goals and objectives. In part two we will describe the origin and purpose of UNST 130. In part three we will describe the goals, objectives, and curriculum of UNST 130. In part four, we will highlight current assessment of student learning strategies and data from UNST 130 *Analytical Reasoning* and describe future assessment strategies that will test our thesis: that UNST 130 *Analytical Reasoning* is of positive value for the Engineering major curriculum.

I

UNST 130 Analytical Reasoning and the Engineering Major Curriculum at NCATSU

Engineering graduates face new challenges because of the revolution in communication and information technologies, the globalization of business, and increased emphasis on teamwork and accountability. It has been apparent for some time that engineering education must provide for students experience with the logical communication skills in the engineering profession. Recently, the National Academy of Engineering published *The Engineer of 2020: Visions of Engineering in the New Century* to predict the roles that engineers will play in the future[i]. They stated that it is "appropriate that engineers are educated to understand and appreciate history, philosophy, culture, and the arts, along with the creative elements of all of these disciplines. The balanced inclusion of these important aspects in an engineering education leads to men and women who can bridge the "two cultures" prominently explored by the author C.P. Snow"[ii]

Also, the Accreditation Board for Engineering and Technology (ABET) gives criteria for engineering programs to follow[iii]. Several of these criteria represent "professional skills" and the objectives of this course can be counted among those skills required for logical reasoning, scientific reasoning, and quantitative reasoning processes to prepare them to interpret and solve problems encountered in everyday life[iv]. In view of these judgments, the NCA&T College of Engineering joined with the Division of University Studies to deliver a three credit hour course entitled "Analytical Reasoning" which is required for all undergraduate students as a part of their common course experience. The uniqueness of this course stems from the fact that it is taught by a large number of faculty representing many disciplines such as philosophy, bioethics, physics, as well as engineering. We believe that in this way students will be exposed to reasoning from a variety of perspectives. Significant for engineering students is the degrees to which this course introduces and or reinforces desired ABET outcomes. NCA&T has learned from others the importance of these analytical skills to engineers but has taken a lead in requiring all undergraduate engineering students to take this reasoning course. A peer institution Virginia Tech has opened an Engineering Communication Center to provide the engineer with top-notch professional skills to complement their technical expertise. Co-directors Marie Paretti and Lisa McNair, faculty members in Virginia Tech's Department of Engineering Education state that in the global marketplace, U.S. engineers need "superior communication and collaboration skills."

Table 1 displays the ABET criteria, a-k, that Culver, et al reorganized into groups that reflect different types of intellectual challenge.[5] They associated a set of skill*s* and attitudes to the outcomes. More specifically, the particular a-k ABET outcomes that are addressed in UNST 130 can be sub-grouped in the table which has been modified from one created by Culver, McGrann and Lehmann.[v] Subgroup II is addressed during portions of the course that center on hypothetical and scientific reasoning. Students explore the four stages of hypothetical method: a. occurrence of a problem, b. formulating a hypothesis, c. drawing implications from the hypothesis and c. testing the hypothesis. An example discussed in length is the historic theory of Spontaneous Generation. What are the roots of the theory? How was the original hypothesis investigated and finally disconfirmed? Students are also introduced to accepted differences in science and superstition and the three underlying principles that must hold true if an event is held to be "science." These principles are: evidentiary support, objectivity and integrity all which are vital concepts for designing and or conducting experiments and or processes. Finally, we discuss and plan simple experiments noting whether the experiment was controlled or uncontrolled, and identifying the independent and dependant variables.

The skill-set found in Subgroup III is also developed by UNST 130 when topics of logic and more specifically arguments are explored. An educated engineer should be able to recognize and employ both deductive and inductive methods and arguments, and evaluate arguments in terms of their validity, truth, soundness, strength, and cogency. They should also have the ability to recognize fallacies in arguments and in ordinary language, both of which will enhance the clarity of their interpersonal communication. Class discussion and active, deep process learning practice of the same topics mentioned above will boost skills found in subgroup IV, specifically outcome f (understanding professional, ethical responsibility) and j (Knowledge of contemporary issues).

Table 1: REORGANIZED ABET a-k CRITERIA[5]

	Outcome Criteria	Knowledge	Skills	Attitudes
I	a. Apply knowledge of math, science, engineering	Applied science	Comprehend technical literature	Value rigorous technical knowledge
	e. Identify, formulate & solve engineering problems	Engineering approach	Effective solution algorithms	Desire to solve technical problems
	k. Use techniques, skills & tools of engineering	Engineering tools	Efficient, effective use of tools	Need to assess limitations of tools
II	b. Design & conduct experiments, interpret data	Experimental method	Laboratory techniques	Empirical stance
	c. Design a system, component or process	Design methodology	Design process, creativity	Open to risk and uncertainty
III	d. Function effectively on multidisciplinary teams	Team dynamics	Interpersonal communication	Valuing others opinions
	i. Ability & desire to pursue life-long learning	Preferred learning style	Self-directed learning	Self-improvement
	g. Communicate effectively	Forms of communication	Writing, public speaking	Clarity & understanding
IV	f. Understand professional, ethical responsibility	Principles of ethics	Analyze situations responsibly	Personal responsibility
	h. Broad education to understand social context	History & social science	Use of multiple perspectives	Social responsibility
	j. Knowledge of contemporary issues	Political & social issues	Evaluating critical issues	Objective analysis of issues

II

UNST 130 Analytical Reasoning: Program Origin and Description

UNST 130 Analytical Reasoning is one of four core courses designed for the three-year-old University Studies Core Course Program at North Carolina Agricultural and Technical State University. All incoming students are required to take UNST 110 *Critical Writing*, UNST 120 *Contemporary World*, UNST 130 *Analytical Reasoning*, and UNST 140 *African American Experience*. This common, core, academic program provides an academic experience for the NCATSU learning community that is rooted in disciplined, intellectual inquiry, critical, rational thinking, effective written and oral communication, and experience with African American and Global world issues. All students, faculties, and alumni of NCATSU know that every student has this common academic basis for conversation and continued learning. University Studies is built on the idea of academic or learning skills-development, rather than knowledge acquisition. The learning objectives that guide the University Studies curriculum stress the development and demonstration of skills, rather than knowledge. These skills are thought to be transferable, applicable to all fields of inquiry, jobs and careers, and personal and civic life.

The faculty senate at NCATSU adopted the University Studies general education model in 2003. The previous general education program was based on the distribution model. The senate vote evolved from a university-wide review of the general education curriculum at NCATSU which began in 2002. University Studies is an independent division within the University with its own dean and dedicated faculty lines. The curriculum includes the four foundation courses identified above, all of which must be completed within the first 32 hours of the student's matriculation. After completing the four foundation courses, as well as UNST 100 University Experience, students commit themselves to a theme based cluster, and complete 12 hours from elective courses in that cluster.[vi] Departments are responsible for another 9 hours within the major that explicitly connect to University Studies themes and learning objectives. A final-year capstone course (1-3 hours) is required, specified by the department. In addition, all students are required perform 50 hours of service-learning in order to qualify for graduation.

Implementation of this new program has taken place over the past three academic years (fall 2006 – spring 2009). The dean of University Studies was hired in August, 2005. In spring of 2006 an interim associate dean was hired. Four dedicated tenure-track University Studies faculty members were hired in 2006, 9 more in 2007, and 5 more in 2008. There are currently 13 tenure-track faculty members with single appointments in University Studies. There are 5 faculty members with joint appointments in University Studies and a department in the College of Arts and Sciences. The foundation courses were offered first the fall of 2006. We are currently in our third year implementing this new general education program.

III

UNST 130 Analytical Reasoning: Goals, Objectives, and Curriculum

UNST 130 is designed to address directly four NCATSU general education learning goals:

> 1) Use analytical thinking skills to evaluate information critically;
> 2) Apply multiple modes of inquiry, including quantitative and qualitative analysis, to formulate, describe, evaluate, and solve problems;
> 3) Apply scientific reasoning skills to model natural, physical, social, and aesthetic phenomena using multiple modes of inquiry; and
> 4) Use a wide range of disparate information and knowledge to draw inferences, test hypotheses, and make decisions.

The course is thus designed to address the "development of broad-based critical thinking skills." Focusing on the concept of "support," UNST 130 seeks to help students develop their understanding of what it means to support one belief or claim using other beliefs or claims; it seeks to help them develop their ability to support their own beliefs and claims;

and the course seeks to help them develop their ability to evaluate others' beliefs and claims, and the attempts of others to support their beliefs or claims. As one NCATSU General Education Committee report articulated, "Science within the Gen. Ed. [*sic.*] sequence needs to be viewed not in terms of traditional disciplines (biology, chemistry, physics, e.g.) but as a "way of thinking" that is applicable in a wide variety of majors."[vii] Consequently, UNST 130 introduces and provides students with the opportunity to reflect on and practice scientific method along with a variety of analytical approaches, including numerical, graphical, verbal/logical, algebraic, statistical, and probabilistic reasoning.

UNST 130 is currently taught by 11 different faculty members. Four have single tenure-track appointments in University Studies. Two have joint appointments with University Studies and Liberal Studies, a new department in the College of Arts and Sciences. Three have non-tenure track lecturer appointments in University Studies. One has appointment in Engineering. One is an adjunct. The course was originally taught by teams. One half of the course was taught by a person trained in philosophy or argument, the second half taught by a person trained in the natural or applied sciences. The course is increasingly being taught by single individuals. Currently, only eight of 16 sections are being taught by teams. Given the number of different people teaching UNST 130, there is much diversity in classroom style and format. Some utilize extensive small group exercises; others utilize more traditional lecture formats. All use TurningPoint student response technology for real time formative assessment of student performance on course learning objectives. During the first two years the course was taught, sections were capped at 160 students. Currently, sections are capped at 63 students.

UNST 130 focuses on helping first-year students develop their understanding of the nature of providing "support" for claims or beliefs. Common to everyday human life is the activity of developing arguments, providing reasons to believe things. All people everywhere practice this reasoning activity, mostly implicitly. And we practice this activity in all areas of our lives. We make reasoned judgments about people, things, and behaviors in our personal lives (e.g., whom to marry and when, how to educate our children, which house or car to buy, which mosque or synagogue to attend, and whether to opt for paper or plastic carry out bags). We make reasoned judgments about people, things, and behaviors in our work lives. And we make reasoned judgments in our entertainment and play lives, whether individual or organized sports, video gaming, card games, or movie watching.

Importantly, UNST 130 seeks to help students develop their capacity to thematize this activity, to make explicit what they already do implicitly, and to provide opportunities for them to practice their newly thematized skills so that they can execute this activity more accurately and efficiently in their future public and private lives. The course thus focuses on the logic of argument, the logic of analysis, and the hypothetical-deductive method of problem solving, generally known as critical thinking, or generic scientific method. Since UNST 130 is a general education core requirement at NCATSU, the skills and analytical reasoning processes it helps students develop are not necessarily directly specific to any particular disciplinary major: we do not teach biology, mathematics, engineering, chemistry, literary theory, or historiography. However, the broad analytical reasoning, critical thinking, and hypothetical-deductive method skills we teach are applicable to all areas of study and human activity in which reason is called upon to guide and direct human belief and behavior.

In its current form, the course begins with a study of the nature of arguments. Arguments are defined as groups of statements one or more of which is claimed to provide reasons to believe another statement. A central concept of the course, and one of the most difficult for most students to grasp in a thorough way, is precisely the nature of "support" that premises supply for conclusions. Although every student makes judgments every day based upon this relationship, most have never thematized it for themselves, that is, they have not reflected on the phenomenon as an intellectual activity. A consequence of this lack of reflection on the activity they all already practice is that when they are confronted with unfamiliar situations, they are easily confused. An objective of the course is to train students to perform better in situations in which they are unfamiliar with the content of the reasoning operations. EXAMPLE

We then introduce inductive and deductive argument forms, help students recognize, analyze, and evaluate arguments. We find that one of the most difficult things for most of our students to grasp is the logical difference between deductive and inductive reasoning forms. Many students, even after many exercises and repeated discussions, continue to mistake psychological certainty for logical certainty. They also struggle to grasp the difference between factual claims and inferential claims. They have trouble suspending their belief in factual claims familiar to them, in order to isolate, analyze, and evaluate a claimed logical relation between factual claims. For example, on one exam we asked the following question:

> You ordered your cheeseburger medium rare. The server brings out the cheeseburger. You try the burger and find it dry, hard, and burned. You conclude that the burger was cooked too long for medium rare.
>
> a. Deductive, valid. (193, 49%)
> b. Deductive, invalid. (17, 4%)
> *c. Inductive, strong. **(173, 44%)**
> d. Inductive, weak. (9, 2%)

We expected this to be a fairly straightforward question, but it was not. Only 44% of our students chose response "c." The conclusion is clearly based on an inductive reasoning process. There are several ways the hamburger could have been prepared that would produce the dry, hard, and burned, taste result, including, that the burger was cooked at too high a temperature, or cooked several years ago and allowed to desiccate. We hypothesize that students' familiarity with the situation and judgment hindered them from seeing the inductive structure of the argument. Their familiarity with the situation and their psychological certainty that they knew the cause of the hamburger's taste, led them to attribute logical certainty, validity, to the argument, and thus assume that the argument was deductive in structure. They understood that deductive arguments have conclusions that are certain. Their psychological certainty about the truth of this conclusion led them to deduce that the argument's structure is deductive. Consider another, similar question:

You put a frozen pizza into the oven and leave the apartment to take out the trash. You write a note for your roommate, who is due home any minute, telling her not to worry. You will be back in time to take out the pizza before it burns. Your roommate returns and reads the note. Since she knows that five out of the last seven times you cooked pizza you left it in the oven too long and burned it, she concludes that she should keep an eye on the pizza while you are gone

a. Deductive, valid. (109, 28%)
b. Deductive, invalid. (14, 4%)
*c. Inductive, strong. **(256, 65%)**
d. Inductive, weak. (12, 3%)

Here, students were on average much more accomplished at recognizing the structure of the argument the roommate made to herself. The argument is clearly inductive, and it is described in some detail in the stem. However, a significant number of students, 28%, thought the argument was deductive and valid. In this case, we are unsure why 28% might have chosen deductive and valid, except, again, that the familiarity of the situation led them to assume that the conclusion, "keep an eye on the pizza when roommate is out" led them to assume logical certainty on the basis of their strong, psychological certainty.

The course then focuses for several weeks on deductive logic. We teach the students basic definitions, forms, and relations among categorical propositions, and then train them to evaluate immediate inferences using the traditional square of opposition. Generally, with practice, most students become adept at using the square to evaluate immediate inferences. For example, 77.78% of 801 students were able to identify that "No oversized gorillas are animals that don't fit in compact cars" is false if "All oversized gorillas are animals that don't fit in compact cars" is true, and 78.78% of the students identified "Some oversized gorillas are not animals that don't fit in compact cars" is also false if "All oversized gorillas are animals that don't fit in compact cars" is true. However, only 51.06% of 801 students correctly identified "Some SUVs are not vehicles that get poor gas mileage" is undetermined if "Some SUVs are vehicles that get poor gas mileage," is true. Interestingly, only 37.08% of 801 students correctly evaluated the following argument, "It is false that all good cell phones are phones sold by Verizon. Therefore, some good cell phones are phones sold by Verizon," as invalid. The complicating "it is false" which begins the premise may represent the complicating factor.

We then spend several weeks studying inductive reasoning. Our focus here is the nature and structure of analogical arguments, especially as used in legal, ethical, and scientific reasoning. Students tend to be adept at analyzing and evaluating simple, everyday examples of analogical arguments. For example, on average out of ten different questions, 76.88% of 801 students correctly identified the effect different factors would have on an analogical argument. They have problems in appropriate places: analogical arguments require knowledge of the subject area. Without that knowledge, it is often difficult to know whether a particular factor affects an argument. They are less adept at analyzing and evaluating moral and legal analogical arguments. Again, their personal commitments to particular legal and ethical views often prohibit them from objective logical assessment of the arguments themselves.

We then turn to scientific reason, hypothetical-deductive reasoning, and experimental design. Our students tend to enter the class with a basic understanding of the terminology: observation, hypothesis, and experiment. For the most part, however, they have not practiced these steps formally (though they all practice them informally in their daily lives), or reflected in any detailed way on how to proceed in unfamiliar settings. Our students tend to have a weak understanding of the nature and language of experimental design. Most of our students have not studied the psychological and social factors that affect objective, logical argumentation. If they have, in classes in psychology or sociology, they have not been trained to see how these factors are related to the creation and evaluation of arguments in their personal and vocational lives. We are currently focusing on developing this part of the course. We hope to develop problem based learning scenarios and other student-activity based learning opportunities so that our students can practice the hypothetical-deductive method more.

The remainder of the course focuses on various kinds of quantitative reasoning. Fractional thinking is central to quantitative reasoning and inductive, hypothetical reasoning. Many students enter with extensive previous study of fractions, decimals, and percentages. However, even those with strong calculation skills, struggle to recognize or articulate the nature of percentages and fractions in conceptual terms. For example, we include a unit on basic financial literacy. When asked to perform a simple percent calculation, 86.46% of 746 students answered the following calculation question correctly:

> If the sales tax rate in the person's state is 6%, how much is the total bill for [a $500] washer?
>
> A. $445.38 B. $445.44 **C. $445.20** D. $445.32 E. $445.26,

while only 70.24% of 746 students responded correctly to the same question, only instead of actually performing the calculation, the student was asked to recognize the conceptual form of the equation:

> Which equation best represents the total cost of a sales-taxed item?
>
> A. Total = tax rate + sticker price
> **B. Total = (tax rate * sticker price) + sticker price**
> C. Total = tax rate * sticker price
> D. Total = sticker price + (tax rate * total)

The financial literacy unit includes simple and compound interest, loans, and home buying. We have discovered that most of our students do not currently possess a well developed financial literacy skills, despite the fact that many of them have had business courses in high school. For example, only 58.98% of 746 students answered the following definition question correctly:

> In the financial context, the word "compounding" means
>
> **A. the interest is added to the principal after each compounding period.**
> B. the interest rate is multiplied by the number of time units.

C. the principal stays the same over time.

D. the interest rate is added to itself after each unit of time.

More sophisticated conceptual skills score lower. For example, for the following question:

In the loan formulas [we supply all formulas on the exam], as the term **m** [number of equal compounding periods in a year] gets larger

A. the compounding period gets longer.

B. the compounding period gets shorter.

C. the duration of the loan gets longer.

D. the interest rate goes down,

which asks students about their understanding of compound interest formulas, only 28.28% of 746 students answered correctly. In contrast, 53.49% of 746 students correctly answered a straightforward compound interest calculation question, and 52.28% of 746 students were able to identify the annual percentage rate when they were given the initial deposit value, future value, and time invested.

Some students, of course, are quite proficient at these quantitative reasoning skills. We believe that more successful teachers find ways to have the proficient students help those who are not proficient, through student-student partnerships, groups, and other collaborative learning structures. Despite the weaknesses of some students, this testing unit consistently scores highest in terms of comprehensive average, of our four major examinations. We reconnect during this unit with our previous work on arguments. Our overarching goal is to help students develop their ability to make and assess arguments based on quantitative reasoning. This reconnecting with earlier parts of the course, inductive and deductive reasoning, is an aspect of the course that concerns us most and on which we are focused in terms of course development.

We finish the course with basic descriptive statistics and the graphical presentation of data. The burden of our introduction to statistics is to help students understand the nature of quantitative data, and to begin to learn to use and apply standard descriptive statistics as representations of data, and to make judgments about data and their meaning on the basis of those descriptive statistics. We do teach students how to calculate mean, mode, median, variance, and standard deviation, and test their skills at performing these calculations, but our long-range goal is to help them to make judgments based solely on given values for these descriptors for a given set of data. The goal of the course is for students to learn to reason and make arguments, not only calculate. Performance values do not currently meet our expectations. For the comprehensive final exam, 95% of 372 students[viii] were able to find the mean of a data set. Only 43% of 372 students were able to calculate the standard deviation of the same data set. Interestingly, 48% of 372 students were able to answer correctly the following conceptual question:

What are the two best measures of a players point scoring dependability?

a. mode and standard deviation　　b. mean and mode

*c. mean and standard deviation　　d. frequency and logic

Future skills questions will ask students to use their conceptual understanding of descriptive statistics to interpret a data set when the statistics values are the only information they have about the data. Developing ways to help students learn to calculate, recognize, and use descriptive statistics in real life situations is our goal.

As a core, foundation course within the General Education program at NCATSU, we think about the purpose of out students' skills development in light of such documents as the 2003 *National Assessment of Adult Literacy: A first Look at the Literacy of America's Adults in the 21st Century*.[ix] *NAAL: A First Look* reports that only 25% of college graduates in the United State are proficient at reading and interpreting documents. Only 31% of college graduates are proficient at quantitative literacy.[x] The study provides examples of proficiency for document reading and quantitative literacy. Interpreting a table about blood pressure, age, and physical activity is an example of document reading proficiency. Computing and comparing the cost per ounce of food items is an example of proficiency in quantitative reasoning.[xi] These are not highly sophisticated benchmarks. Of especial importance to us at North Carolina Agricultural and Technical State University, a historically Black, land grant institution, is the finding that only 2% of African Americans are proficient in document and in quantitative literacy.[xii]

V

Assessing UNST 130 Analytical Reasoning

As a division, University Studies employs student response technology ("responders") to provide real-time formative assessment in the classroom. This technology has been so successful that many teachers conduct extensive practice sessions using the responders. Some attempt to use a question-based format for instruction, teaching concepts, content, and skills using the interactive capacity of the responders. Question-heavy sessions can have 30-40 questions. Review days might reach 50 questions. There are some teachers who do not employ the student response technology extensively. These sections may average only 2-4 questions per day. Responder session files are saved after each session. Response system software can generate many different kinds of reports presenting the data from the class sessions. This data documents real-time formative assessment. Daily student data is downloaded to Blackboard Grade Center. Students can see their cumulative daily performance and their trends over time.

The division also employs pre- and post-tests in all of its foundation courses. UNST 130 administers its pre-test on the first day of class, and it post-test on the last day of class. Students who miss class on those days have no pre- or post-test scores. Pre- and post-test data is collected each semester for each student, each section, and for the course as a whole. Average performance increase for all students who take either the pre-test or the post-test has been consistently 15% -20% for the past 3 semesters. Of those who completed both the pre-test and the post-test in fall 2008 (62.2% of those who finished the course), 69.3% improved by at least 20%. Of those who completed both pre-test and post-test during the spring of 2008 (65.2% of those who finished the course), 72.3% improved by 20% or more. We use control questions on the pre-test and post-test. Control questions are questions which ask students about concepts or skills that we do not teach in the course. Control questions show no change from the pre- to the post-test. We attribute the change in performance on the questions whose concepts and skills we teach to class instruction and learning. Composite average improvement from the pre- to the post-test includes the control questions for which there is no change. This reduces the overall average percent improvement as a raw number. If we eliminate the control questions from our average, we see that on average, our students improved by 87.9% from the pre-test to the post-test.

How do Engineering majors perform on the pre- and post-test?

A comparison of Engineering and non-engineering majors on the pre-test shows that engineering majors averaged 6.34 questions correct out of 15. Non-engineering majors averaged 5.43 questions correct out of 15. Anova analysis suggests that the difference is significant.

Table 2: Anova Single variable Pre-Test

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Engineering Pre-Test	35	223	6.371429	4.29916
NonEngineering Pretest	399	2168	5.433584	4.140678

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	28.30173	1	28.30173	6.814519	0.009356	3.863074
Within Groups	1794.161	432	4.153151			
Total	1822.463	433				

A comparison of the engineering and non-engineering post-tests shows that Engineering majors average 8.46 questions correct out of 15 and non-engineering majors average 7.83 questions correct out of 15. Anova analysis suggests that the difference is not significant.

Table 2: Anova Single variable Post -test

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
NonEngineering Posttest	399	3125	7.83208	6.38128
Engineering Post-Test	35	296	8.457143	5.196639

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	12.57182	1	12.57182	1.999322	0.15809	3.863074
Within Groups	2716.435	432	6.288044			
Total	2729.007	433				

The sample of engineering majors is small for fall 2008. Data collection for the Engineering only section of 60 students was corrupt. Data for those 60 students is not available. Generally, we would have to say that, given the sample, although Engineering majors enter the course with a statistically higher performance value, they do not leave the class with a statistically higher performance value.

A further course assessment strategy is to track section performance for each exam and compile comparative data by section for pre- and post-tests, and the four major examinations. These data allow us to see how a particular section performed on the pre-test, each of the four major exams, and the post-test. These data reveal variation among sections from exam to exam, section to section, and semester to semester. Though there are broad general trends, particular sections, instructors, and semesters vary.

A planned assessment involves administering the UNST 130 Pre- and Post-Test to second, third, and fourth year students. The performance scores on these tests will be correlated with individual student performance scores from their UNST 130 sections. These correlated scores will then be correlated with student's curriculum track. We hope to see whether certain curriculum tracks build on the skills developed in UNST 130, and whether other curriculum tracks do not. We expect the Engineering curriculum tracks to correlate positively with the skills developed in UNST 130.

Conclusion

We believe that UNST 130 *Analytical Reasoning* is a positive course for engineering majors at NCATSU. Specific logical, analytical, scientific, critical, and quantitative reasoning skills match well with stated desired skills for engineering majors. The ABET a-k Criteria call for precisely the curriculum offered by UNST 130. Exam question assessment and pre- and post-test assessment of student learning reveals that many students at NCATSU need to develop these reasoning skills and are positively affected by their participation in UNST 130. So far, data shows that Engineering majors enter the course performing at a higher level that non-engineering majors, and leave the course performing higher in absolute terms, though that performance does not appear to be statistically different from the non-engineering major.

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6. Current clusters are: Science, Technology, and Society; Energy, Environment, and Society; Community, Conflict, and Society; Health, Lifestyles, and Society. A fifth cluster, Philosophy, Religion, and Society, has been developed and proposed for adoption, is currently under review in the faculty senate.

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[iv] Shuman, Larry J., Mary Besterfield-Sacre, and Jack McGourty, "The ABET "Professional Skills" – Can They Be Taught? Can They Be Assessed?" Journal of Engineering Education, Vol. 94, No. 1, pp.41-55.
[v] Culver, Richard, McGrann, Roy, Lehmann Gary, "Preparing Students for ABET a – k", 35th ASEE/IEEE Frontiers in Education Conference, Indianapolis, IN, October, 2005
[vi] Current clusters are: Science, Technology, and Society; Energy, Environment, and Society; Community, Conflict, and Society; Health, Lifestyles, and Society. A fifth cluster, Philosophy, Religion, and Society, has been developed and proposed for adoption, is currently under review in the faculty senate.
[vii] **General Education Core Curriculum Review Committee**
Progress Report Covering the Period: August 2003 - December 2003
[viii] 372 is the number of students who took version one of two versions of the final exam.
[ix] National Assessment of Adult Literacy: A First Look at the Literacy of America's Adults in the 21st Century, 2003, http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2006470
[x] NAAL: A First Look, 2003, p. 15.
[xi] NAAL: A First Look, 2003, p. 3.

[xii] NAAL: A First Look, 2003, p. 9. By comparison, 15% of Whites are proficient in document literacy and 17% are proficient in quantitative literacy.