Assessment of Introduction to Engineering and Problem-Solving Course

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Abstract

At North Carolina State University, the freshmen's first course in engineering is E101, Introduction to Engineering and Problem-Solving. It is offered each fall to over 1,100 first year engineering students. In an effort to continuously improve the course, we put into place a plan to assess the course's learning outcomes. Assessment data collected in fall 2001 and fall 2002 through surveys, rubrics, and class assignments were evaluated to determine how well students met learning outcomes related to communication, teamwork, and problem-solving. This paper presents the assessment methods used in this course and provides examples of how the assessment findings were used to modify the course. The assessment procedures developed for this course can be modified for use in any course, regardless of its size, and will illustrate how course assessment can be used to make course and program improvements.

Model for Assessment

Last year, we presented a model for assessment that describes what data to gather, where to obtain the data, what criteria may be most appropriate when interpreting the data, how to use the results to make improvements in program and how to document the process.[1] The present paper illustrates how that model can be implemented to assess the E101 Introduction to Engineering and Problem -Solving course. The assessment model can be summarized into four major steps:

Step 1: Defining program mission, objectives, and outcomes;
Step 2: Developing an assessment plan to assess the program objectives and outcomes with linkages to curriculum issues and implementation;
Step 3: Gathering the data into a database;
Step 4: Interpreting the data to determine program effectiveness and implementing

program improvements.

Because of the size of the incoming freshmen class at NCSU of over 1,100 students each year, the E101 course can be seen as a program and therefore many of the methods for program assessment have been applied to this course. This one-semester hour course is taught in small sections of 40 to 50 students, with approximately 15 faculty participating in teaching the course during the fall semester each year. All sections are taught in the same way, with the same goals, objectives and outcomes, the same assignments and the same assessment methods. A thorough description of this course can be found in a companion ASEE paper (#1653): *The First Year Engineering Course at NC State University: Design and Implementation*, by Jerome P. Lavelle and Mary Clare Robbins[2]. The faculty who taught this course met periodically to discuss the assessment plan, set performance standards, discuss the assessment results, and suggest improvements to the course.

Step 1: Defining E101's Mission, Objectives and Outcomes

Assessment of E101 began formally in the fall of 2001, by the faculty defining the course goals and outcomes (See Table 1). In this case, the overall goal of the course can be seen as its mission.

Table 1: Goals and Learning Objectives of the E101 Course, Fall 2001

Goals and Objectives of the Course: This course is designed to introduce students to the field of Engineering and the study of Engineering. Objective: Students will be able to integrate computer usage, teamwork, problem solving, and verbal/written language into a design project within the course in such a way that these skills become the foundation of a successful engineering career. Objective: An early understanding of these skills will assist students throughout their undergraduate experience and beyond.

E101 Course Learning Outcomes

By the end of the semester, students will be able to:

1. Solve engineering problems by working on teams,
2. Apply a structured design process in solving engineering problems,
3. Demonstrate how and when to apply computer tools to solve engineering problems,
4. Present engineering problems and solutions in both written and oral presentation modes,
5. Understand specifics of the engineering disciplines and careers in engineering,
6. Discuss resources and opportunities on campus that assist in student's goals.

Step 2: Developing An Assessment Plan

Strategies for implementing and assessing the outcomes were then identified for each learning outcome. Each outcome was linked to an appropriate ABET programmatic criteria 3a-k.[3] Table 2 shows the assessment plan developed for the fall of 2001. Note that for each learning outcome, there is a strategy for how the instructors will teach to that outcome, methods for how the outcome will be assessed, and a list of related ABET criteria 3a-k. Once the faculty determined the assessment methods, including rubrics, then the rubrics were developed, tested and implemented during the fall of 2001. The authors of this paper developed these rubrics to assess design problem solving, writing ability, oral presentation skills and teamwork. Student Engineering Leaders (SELs), upper-level engineering students who served as TAs for the various sections of the course, were used to assist with the course and were trained on how to use the various assessment methods. Each section of the course used the same assessment methods and rubrics. By the end of the course, data had been collected for each outcome.

Table 2: Assessment Plan for E101 for Fall 2001

Course Learning Outcomes	Strategies for Implementing Outcome	Assessment Methods	Relates to ABET Criteria 3 a-k
1. By the end of the semester, students will be able to solve engineering problems by working on teams.	Team of 4 persons to work on the design project throughout the semester.	-Students complete a rubric about the team experience during last week of class. Outcome met if 75% of students received "4" or "5" on each dimension of the rubric. -Course evaluation: Outcome met if 75% of students feel the course contributed to their knowledge at a high level ("4" or "5" on five point scale). -Grading Rubric for written paper: Dimension on teamwork: Outcome met if the average of 2.5 or higher on this dimension.	(d) Graduates have an ability to function on multi-disciplinary teams.
2. By the end of the semester, students will be able to apply a structured design process in solving engineering problems.	Design process taught. Each team will solve one problem by end of course.	-Grading Rubric for written paper to assess how well they applied the design process to the project. Outcome met if the average of 2.5 or higher on each dimension of rubric.	(b) Graduates have an ability to design and conduct experiments, as well as to analyze and interpret data.
3. By the end of the semester, students will be able to demonstrate how and when to apply computer tools to solve engineering problems.	Students use PowerPoint and Excel software with assignments.	-Grading Rubrics for computer software use and oral presentations applied to assignment problems. Outcome met if the average of 2.5 or higher on each dimension of the rubrics.	(k) Graduates have an ability to use the techniques, skills, and modern engineering tools.
4. By the end of the semester, students will be able to present engineering problems and solutions in both written and oral presentation modes.	Students given at least one opportunity to write a paper and one opportunity to do an oral presentation.	-Grading Rubrics for written paper and oral presentation applied to determine student's ability in writing and oral presentations and ability to solve the problem. Outcome met if the average of 2.5 or higher on each dimension of rubrics.	(g) Graduates have an ability to communicate effectively.

5. By the end of the semester, students will be able to understand specifics of engineering disciplines and careers in engineering.	Each student given multiple opportunities to visit each discipline area and discuss each discipline with professionals in the area.	-Course evaluation: Outcome met if 75% of students feel the course contributed to their knowledge at a high level ("4" or "5" on five point scale). -Attendance at informational sessions will be monitored and the outcome met if at least 75% of those who attended consider the session high quality.	Not applicable
6. By the end of the semester, students will be able to discuss resources and opportunities on campus that assist in student's goals.	Class discussion and textbook readings.	-Course evaluation: Outcome met if 75% of students feel the course contributed to their knowledge at a high level ("4" or "5" on five point scale).	Not applicable

Step 3: Gathering The Data Into a Database

This section describes how each tool described in the assessment method section of the assessment plan was developed and how the data from each method was gathered. All data collected as part of the assessment plan was placed in a database and kept by the Director of Assessment for the College of Engineering. Since she was not a faculty member for this course, she could provide non-biased, independent analyses of the data for use in assessing the course outcomes. The data was collected during the fall of 2001 and the fall of 2002. Differences in course sections were examined; it was determined that there was little significant differences between sections. Therefore, all the data was treated the same, regardless of the course section.

One of the main tools used for assessing learning outcomes 1, 2 and 4 was the Grading Rubric for Written Papers. The authors of this paper first developed this rubric for use during the fall of 2001. During the fall of 2001, the SELs (TAs) were trained on how to grade the papers using the rubric and normalized on their grading using several papers from the prior year. The rubric was evaluated after its use on the first paper that the students had to write during week four of the course. Based on comments from the SELs and the students, and the authors' discussions, the grading rubric was slightly modified for use for the written paper the student had to complete on their main design project for the course during the fall of 2001. As seen from other assessment findings from the fall of 2001 discussed below, the grading rubric was modified once more for use during the fall of 2002. The final version of the rubric for the written paper has 20 criteria. Each criterion is scored on a scale of 1 "Poor" to 3 "Excellent." This rubric can be found in Appendix A. The scores on each of the criterion of the Grading Rubric for Written Papers for each student team for both fall 2001 and fall 2002 were put into the E101 assessment database.

For use in assessing learning outcomes 3 and 4, the authors developed the Grading Rubric for Oral Presentations in the fall of 2001. The faculty used this rubric each time a student made a presentation. Students made at least one presentation during the fall 2001 course. Most faculty used the rubric as a guide for grades and did not keep scores on each presentation. Students were given the scored rubric for use to improve their oral presentation skills. In the fall of 2001, many of the groups did not have an opportunity to give their final oral presentation; therefore, there was no data for use in assessing student's oral presentation skills in the fall of 2001. However, using the verbal feedback from the students and faculty, the Grading Rubric for Oral Presentations was modified to add criterion on presentation style and timing. For the fall of 2002, the student teams were given more practice with oral presentations by including one presentation per team early in the fall 2002 semester and including time in the schedule for each member of each team to make the final design project presentation. During the fall 2002 semester, the faculty used the rubric to evaluate both presentations. See Appendix B for the oral presentation rubric used in fall of 2002. The scores on each criterion on the Grading Rubric for Oral Presentations for the final design project presentation for fall 2002 were put into the E101 assessment database.

In order to implement learning outcome 1, the students were assigned to teams of four students during the first of the semester and worked with the same team throughout the semester on various projects, including their major design project. The authors developed a teamwork rubric during the fall 2001. Each student, to assess their teammates' effort and contribution to the design project and paper, rated their teammates using the rubric. The scores were put into the assessment database. During the fall of 2001, the faculty used the scored rubrics to determine if a student's individual grade on the final design project needed to be modified. During the spring of 2002, one of the authors located a more appropriate teamwork rubric on the web.[4] The authors modified this rubric and tested it on a small section of E101 during the spring of 2002. It was found to be more useful than the rubric developed in the fall of 2001. Therefore the students used this new rubric during the fall of 2002 to score their teammates. Each student rated teammates on each dimension of the rubric and then each data point was put into the E101 assessment database. See Appendix C for the teamwork rubric used in fall of 2002.

During the fall of 2001, a course evaluation survey instrument was developed to help assess the effectiveness of the course and to assess learning outcomes 1, 5, and 6. Students completed the Course Evaluation Survey at the end of each semester. This survey was slightly modified for use during fall of 2002. A copy of the survey can be found in Appendix D. The data on each question was kept in the assessment database.

Step 4: Interpreting The Data To Determine Program Effectiveness And Implementing Program Improvements.

For each outcome, not only was the assessment method defined, but the faculty for this course, as a group, determined performance standards for each method. These standards are summarized in the assessment plan (Table 2). These standards were used to interpret the data and determine strengths and weaknesses. The faculty discussed the findings during an assessment meeting in the spring of 2002 and made decisions about modifications for fall of 2002. The data was collected during the fall of 2002 semester as described above. Below is a discussion about what was found from the assessment methods for each of the 6 learning outcomes for this course for both fall of 2001 and fall of 2002. Data was analyzed as a whole for the course, as differences between sections were non-significant. Comparison of the data from each semester and how changes in the course affected student learning as seen by the assessment data are discussed.

<u>Outcome 1: By the end of the semester, students will be able to solve engineering problems by</u>

working on teams.

In the fall of 2001, the teamwork rubric was not analyzed for assessment purposes. In the fall of 2002, the teamwork rubric showed that the students felt strongest about their teammates' ability to communicate. The teams indicated that most members (75%) could listen and speak appropriately while working in their teams. The students rated 50% of their teammates as being able to make good contribution to the work, and 45% making contributions of high quality. Each dimension of the teamwork rubric had at least 82% of the students rate their teammate as a "4" or "5", which exceeds the performance standard set by the faculty: Outcome met if 75% of students received "4" or "5" on each dimension of the rubric. See Table 3 for results from the teamwork rubric.

Table 3: Assessment Findings and Improvement to Program Based on Outcome 1

Outcome 1: By the end of the semester, students will be able to solve engineering problems by working on teams

Assessment Findings Fall 2001	**Modifications Made for Fall 2002**	**Assessment Findings Fall 2002**
Teamwork Rubric was used by instructor to decide if each team member should get the same grade on the final project. A few grades were modified.	For Fall 2002, data on Teamwork rubric should be collected to determine areas of weakness.	Findings from teamwork rubric on each dimension: I Share of tasks assumed 4.48 II Contribution /Quality of Work 4.21 III Team Spirit 4.48 IV Dependability 4.24 V Communication 4.62 VI Overall Evaluation 4.48
Course evaluation showed that 70% of the students felt that the course contributed to their knowledge about working on teams and understanding the importance of teams. Although this did not make the 75% criteria, this was a high rating compared to other topics.	Next time, faculty should have more discussion about why they need to work on teams.	Course evaluation showed that 79% of the students felt that they had learned about working on teams and 77% felt that they had an understanding of the importance of teams. This is an increase compared to the previous year.
Rubric for Final Design Project: Dimension on teamwork: paper clearly describes team structure and issues related to teamwork: 2.60 average		Rubric for Final Design Project: Dimension on teamwork: paper clearly describes team structure and issues related to teamwork: 2.73 average

As seen in Table 3, the course evaluation survey for the fall of 2001 showed that 70% of the students felt that the course contributed to their knowledge about working on teams and understanding the importance of teams. The faculty discussed this finding and suggested that next time the faculty should spend more time discussing teamwork. The scores from the fall 2002 course evaluation suggested that this extra time was beneficial – 79% of the students felt that they had learned about working on teams.

The Grading Rubric for Written Papers score on the dimension on teamwork ("paper clearly describes team structure and issues related to teamwork") on the final design project showed that it increased from an average of 2.60 in fall of 2001 to an average of 2.73 in the fall of 2002. The findings from fall 2002 showed that the students exceeded the performance standards set by the faculty: Outcome met if the average of 2.5 or higher on teamwork dimension.

Outcome 2: By the end of the semester, students will be able to apply a structured design process in solving engineering problems

Assessment of outcome 2 was determined from many of the dimensions on the Grading Rubric for Written Papers. The scores from the rubric on all of the final design projects were analyzed for the fall of 2001 (See Table 4). Each dimension was scored on a scale of 1 "Poor" to 3 "Excellent." It was found that dimensions such as *Understanding Overall Design Process, Problem Identification and Working Criteria, Project Testing,* and *Drawing of Design* had a high average. The dimensions with the lowest average included *Presenting a Gantt Chart of Tasks, Identifying Solutions Alternatives, Identifying Multiple Research Sources, Writing About Project Management Of Resources,* and *Summarizing Research Sources.*

Table 4: Assessment Findings and Improvement to Program Based on Outcome 2
Outcome 2: By the end of the semester, students will be able to apply a structured design process in solving engineering problem.

Assessment Findings Fall 2001	**Modifications Made for Fall 2002**	**Assessment Findings Fall 2002**
Grading Rubric for Written Papers on the Final Design Project showed the following:		Grading Rubric for Written Papers on the Final Design Project Rubric showed the following:
Highest dimensions across all students: Dimension: Average: Problem Identification Working Criteria 2.85 Understanding Overall Design Process 2.82 Testing Design 2.70 Drawing of Design: 2.63		Comparison to Fall 2001 Dimension: Average: Problem Identification and Working Criteria 2.71 Understanding Overall Design Process 2.73 Project Testing 2.70 Drawing of Design: 2.69

Lowest dimensions across all students: Dimension: Average: Presenting a Gantt Chart of Tasks 2.53 Identifying Solutions Alternatives 2.53 Identifying Multiple Research Sources 2.48 Writing About Project Management Of Resources 2.46 Summarizing Research Sources 2.41	-Instead of stressing a specific kind of chart, such as Gantt Chart, faculty may discuss any type of project scheduling tool they feel is appropriate. -Course needs to help students with identifying multiple sources of background information and how to use that information – therefore an information literacy module will be added to next fall's course.	Comparison to Fall 2001 Dimension: Average: Gantt Chart dimension changed to Project Scheduling tool 2.71 Identifying Solutions Alternatives 2.59 Identifying Multiple Research Sources 2.38 Writing About Project Management Of Resources 2.46 Summarizing Research Sources 2.42

Based on these finding from the fall of 2001, it was determined that students were not able to identify research sources except on the Internet; they could not differentiate between the quality of research sources and they could not summarize the sources they found. Therefore, the faculty decided that the E101 course should include an information literacy module to help students with identifying multiple sources of background information and how to use that information.

A module was developed and delivered to the students in partnership with the university engineering librarians. Honora F. Nerz and Suzanne T. Weiner of North Carolina State University reported in 2001 ASEE conference paper about this type of approach for teaching information literacy.[5] The students were given hands-on practice finding information and determining how to use it. The module included a homework assignment where students gathered references and made a summary of the sources. This specific module was piloted in the spring semester 2002 and fully implemented in fall 2002. It was speculated that this module would increase the students' ability and that the students' score on the rubric on the fall 2002 final design papers would improve on the dimensions related to this topic.

Even though the module on information literacy was added, the students in the fall of 2002, on average, did not improve on the following dimension on the rubric for the written paper on their final design project: *Identifying Solutions Alternatives, Identifying Multiple Research Sources, Writing About Project Management Of Resources,* and *Summarizing Research Sources*. See Table 4 for specific data. The faculty will meet later this semester to determine other strategies for improving this outcome.

Another improvement the faculty made for the fall of 2002 was in reference to the Gantt Chart of Tasks. Since the Gantt Chart of Tasks had an unacceptable low average in the fall of 2001, the faculty would not specify this tool as the tool of choice. Instead of the Gantt Chart, each faculty member in the fall of 2002 should discuss the project scheduling tool or tools they thought the students should use. In fall of 2002, the project scheduling tool dimension increased to an average of 2.71 (compared to 2.53 for the Gantt Chart dimension in fall of 2001).

<u>Outcome 3 (fall 2001): By the end of the semester, students will be able to demonstrate how and</u>

when to apply computer tools to solve engineering problems. Modified for fall 2002: By the end of the semester, students will be able to demonstrate how and when to apply analytical methods to solve engineering problems.

After examining the assessment data from fall 2001, the faculty of the course determined that most students had a basic knowledge of Excel and PowerPoint, but that the real issue was for students to begin to understand how to apply math, physics and other science principles to an engineering problem. Therefore, the outcome was modified and more emphasis was placed on analytical methods during the fall of 2002. To assess this outcome, a dimension on analytical method was added to the Grading Rubric for Written Papers. This dimension asked students to explain how math, physics and other science principles were appropriate to their engineering problem. For fall 2002, the students had an average of 2.5 on this dimension (scale from 1 "poor" to 3 "excellent"). The faculty considered this satisfactory and it met the performance standard set by the faculty: Outcome met if the average of 2.5 or higher on each dimension of the rubric.
Outcome 4: By the end of the semester, students will be able to present engineering problems and solutions in both written and oral presentation modes.

In the fall of 2001, the data from each of the six dimensions of the Grading Rubric for Written Papers related to writing were analyzed. The students met the faculty performance standard on these dimensions of scoring higher than 2.5 on average. See Table 5 for specific results.

In fall 2001, the Grading Rubric for Oral Presentations scores were not kept for assessment purposes. However, for the fall 2002, data from 40 teams (out of approximately 250 teams) data from this rubric were kept and analyzed. The students were rated high by the faculty on all dimensions except Organization (2.4 average). See Table 5 for specific results.

Table 5: Assessment Findings and Improvement to Program Based on Outcome 4

Outcome 4: By the end of the semester, students will be able to present engineering problems and solutions in both written and oral presentation mode.

Assessment Findings Fall 2001	**Modifications Made for Fall 2002**	**Assessment Findings Fall 2002**
Grading Rubric for Written Papers, dimensions on WRITING, on the Final Design Project, showed that the students met performance standard for writing skills on the final paper:		Grading Rubric for Written Papers, dimensions on WRITING, on the Final Design Project, showed that the students met performance standard for writing skills on the final paper:
Dimension: Average: Structure of paper 2.76 Conclusion 2.76 Grammar 2.73 Focus and flow 2.73 Intro 2.73 Style 2.67	No modifications needed	Dimension: Average: Structure of paper 2.71 Conclusion 2.66 Grammar 2.76 Focus and flow 2.63 Intro 2.73 Style 2.76

Grading Rubric for Oral Presentations used for overall judgment and scores not kept on each team.	No modifications needed except to add more dimensions on presentation style and timing	The following are the results from 40 teams on their final design Oral presentation: Average Organization 2.4 Content Knowledge 2.9 Grammar and Spelling 2.9 Style 2.8 Visual Impact of Slides 2.9 Professionalism 2.9 Presentation Style 2.8 Delivery 2.8 Transition Between Speakers 3.0 Timeliness 2.9

Outcome 5: By the end of the semester, students will be able to understand specifics of the engineering disciplines and careers in engineering.

In the fall of 2001, the course evaluation survey asked the students to rate their knowledge about specifics issues related to engineering. The data from the survey were analyzed and it was found that this outcome was not met as determined by the performance standard for this outcome. (See Table 6). The faculty determined that this outcome could be improved by placing more emphasis on these topics. In addition, the faculty conducting informational sessions were given feedback about their sessions so that they could improve them. The faculty also determined that students would learn about each discipline if they had more active learning assignments. In the fall of 2002, each team of students developed a presentation about one discipline.

The results from the course evaluation survey for the fall of 2002 showed that students understanding of the engineering disciplines had increased, but not to the level of the performance standard. The student ratings of the informational sessions showed improvement and most sessions met the expected performance standard. Overall, this outcome still needs work. See Table 6 for specific results.

Table 6: Assessment Findings and Improvement to Program Based on Outcome 5
Outcome 5: By the end of the semester, students will be able to understand specifics of the engineering disciplines and careers in engineering.

Assessment Findings Fall 2001	Modifications Made for Fall 2002	Assessment Findings Fall 2002
Course Evaluation asked students to rate contribution that E101 made to their knowledge of the following topics. Outcome met if percentage higher than 75%.		Course Evaluation asked students to rate degree they had learned the following topics. Outcome met if percentage higher than 75%.

Topics — Percentage who said "4 or 5" Engr Design 71% Projects 71% Understand Teamwork 70% **Team work** 70% Engr Failure 66% Engr Disciplines 64% Engr as a Profession 64% Communication 57% Ethics 57% Personal/ Professional Development 50% Current Events 50% Problem-Solving 49%	This outcome could be improved by more time on these topics and more active participation by students about each discipline. Next fall, each team will learn about and give a presentation about one discipline.	Topics — Percentage who said "4 or 5" Engr Design 71% Projects 72% Understand Teamwork 77% **Team work** 79% Engr Failure 66% Engr Disciplines 68% Engr as a Profession 68% Written Communication 57% Oral Communication 64% Ethics 64% Personal/ Professional Development 67% Current Events 39%
Number of students who attended Information Sessions on each program and their ratings of the session. Info Session Attended / Number who attended / Percentage who rated session "4 or 5" BE 146 66% CHE 84 69% CE 95 63% CSC 128 67% ECE 219 57% IE 56 70% MTE 239 88% MAE 120 67% NE 54 74% TE 43 75%	Faculty running informational sessions were given this feedback and asked to improve their sessions.	Number of students who attended Information Sessions on each program and their ratings of the session. Info Session Attended / Number who attended / Percentage who rated session "4 or 5" BE 99 73% BME 143 72% CHE 90 74% CE 245 85% CME 55 75% ENE 74 69% CSC 107 73% EE 165 65% CE 153 69% IE 94 85% MTE 180 78% MAE 200 75% NE 139 82%

<u>Outcome 6: By the end of the semester, students will be able to discuss resources and opportunities on campus that assist in student's goals</u>

In the fall of 2001, the course evaluations surveys were collected and analyzed at the end of the semester. These results showed that students did not feel that they had learned much about topics related to policies and procedures or about the various disciplines in engineering.

Table 7 displays complete results for Outcome 6. The faculty also decided that having the students self-assess knowledge on policies and procedures was not as good as actually testing their knowledge. Therefore, for the fall 2002 course, the students took an exam on the policies and procedures. They were able to take the test one time, but could use their textbook. Of the forty questions, 4 questions were found to be misleading or badly worded. Each of the other questions was analyzed to determine the number of students who did not get the answer correct. If more than 10% of the students did not get a question correct, then the faculty felt that this was an area that students may not have understood and may need some clarification the next time the course is taught. Five questions had more than 10% of the students respond incorrectly. These questions reflected the topics of:

- when a student could repeat a course,
- the number of departments and majors within the College of Engineering,
- requirements for matriculation, and
- understanding of their responsibility towards meeting prerequisite course requirements.

Table 7: Assessment Findings and Improvement to Program Based on Outcome 6
Outcome 6: By the end of the semester, students will be able to discuss resources and opportunities on campus that assist in student's goals.

Assessment Findings Fall 2001	**Modifications Made for Fall 2002**	**Assessment Findings Fall 2002**
Course Evaluation asked students to rate contribution that E101 made to their knowledge of the following topics. Outcome met if percentage higher than 75%.		Course Evaluation asked students to rate degree they had learned the following topics. Only a few topics were on the course evaluation survey, as most of the topics were tested on the exam. Outcome met if percentage higher than 75%.
Topics — Percentage who rated session "4 or 5" Matriculation 66% Advising 61% C-Wall 49% FYC Repeat 48% Interns 45% Co op 45% Dual Degrees 38% Minors 37% Study Abroad 32% Course Instructor 76% Course SEL (TA) 78% Classroom Facilities 75% Computer Facilities 78%	Lowest ratings were on these topics. Next fall, faculty need to clarify these policies and procedures more clearly.	Topics — Percentage who rated session "4 or 5" Course Instructor 86% Classroom Facilities 79% Computer Facilities 82%

	Faculty also determined that it would be better to test student knowledge in these areas rather than ask their opinion if they had learned about these areas.	Students in fall 2002 were given an exam about policies and procedures. Only five questions had more than 10% of the students respond incorrectly. These questions reflected the following topics: • when a student could repeat a course, • the number of departments and majors were within the College of engineering, • requirements for matriculation and • understanding of their responsibility towards meeting prerequisite course requirements.

Modified Assessment Plan

Table 8 below incorporates the changes made to the assessment plan and shows the newest plan. This plan was implemented beginning fall of 2002.

Table 8: Modified Assessment Plan for E101 for Fall 2002

Course Learning Outcomes	Strategies for Implementing Outcome	Assessment Methods	Relates to ABET Criteria 3 a-k
1. By the end of the semester, students will be able to solve engineering problems by working on teams.	Team of 4 persons to work on the design project throughout the semester.	-Students complete a rubric about the team experience during last week of class. Outcome met if 75% of students received "4" or "5" on each dimension of the rubric. -Course evaluation: Outcome met if 75% of students feel they understand about this topic at a high level ("4" or "5" on five point scale). -Grading Rubric for written paper: Dimension on teamwork: Outcome met if the average of 2.5 or higher on this dimension.	(d) Graduates have an ability to function on multi-disciplinary teams.
2. By the end of the semester, students will be able to apply a structured design process in solving engineering problems.	Design process taught. Each team will solve one problem by end of course.	-Grading Rubric for written paper to assess how well they applied the design process to the project. Outcome met if the average of 2.5 or higher on each dimension of rubric.	(b) Graduates have an ability to design and conduct experiments, as well as to analyze and interpret data.

3. By the end of the semester, students will be able to demonstrate how and when to apply analytical methods to solve engineering problems.	The small design project and the final design project both incorporate how math and science principles impact the problem and design	-Grading Rubric for written paper added dimensions to assess how well students apply math and science principles to the design of their projects. Outcome met if the average of 2.5 or higher on each dimension of the rubrics.	(a) Graduates have an ability to apply knowledge of mathematics, science, and engineering. (e) Graduates have an ability to identify, formulate, and solve engineering problems.
4. By the end of the semester, students will be able to present engineering problems and solutions in both written and oral presentation modes.	Students given at two opportunities to write a paper and three opportunities to do an oral presentation.	-Grading Rubrics for written paper and oral presentation applied to determine student's ability in writing and oral presentations and ability to solve the problem. Outcome met if the average of 2.5 or higher on each dimension.	(g) Graduates have an ability to communicate effectively.
5. By the end of the semester, students will be able to understand specifics of engineering disciplines and careers in engineering.	Each team will investigate one discipline and give a class presentation about the discipline. Each student given multiple opportunities to visit each discipline area and discuss each discipline with professionals in the area.	-Course evaluation: Outcome met if 75% of students feel they understand this information at a high level ("4" or "5" on five point scale). -Attendance at informational sessions will be monitored and the outcome met if at least 75% of those who attended consider the session high quality.	Not applicable
6. By the end of the semester, students will be able to discuss resources and opportunities on campus that assist in student's goals.	Class discussion and textbook readings.	-Exam on policies and procedures.	Not applicable

Conclusion

The assessment procedures and steps for programs as defined by our model have been followed here: The faculty defined a set of objectives and outcomes, which also reflected the ABET Educational Criterion 3; they determined and developed appropriate assessment methods; and they used the assessment methods in the course to gather data into a database. At the end of the fall 2001 semester, they analyzed the assessment data and made decisions about whether or not the students were meeting the learning outcomes. They made recommendations for improvement of the course and modified the outcomes and assessment methods. The next time the course was taught, they used the same and revised assessment methods, then analyzed the new set of data. The data reflected whether or not the suggested improvements and modifications made a difference to student's learning related to each outcome. It should also be noted that the assessment methods developed were used for both determining individual student grades as well as assessing program outcomes. This procedure allows for the most efficient use of faculty's time and effort.

Because this course is offered during the student's first semester, it will be interesting to track the progress of these students in their ability to solve engineering problems. The rubrics designed for the written paper, which has dimensions relating to the engineering problem-solving process, are being considered for use in upper-division engineering courses. Additionally, to help with the effort of upper-division courses assessing teamwork, the teamwork rubric is being piloted in an upper-division engineering course.

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Appendix A
Grading Rubric for Written Papers, Fall 2002

	Poor (1 point)	Average (2 points)	Excellent (3 points)	Points
Introduction	• No attempt to explain context in which project was done. • Paper does not indicate why design process is important.	• Discussion of why design process is important is disorganized or missing some issues.	• Clearly explains purpose of the design project within the context of the course. • Clearly organized discussion of why design process is important.	
Problem Identification & Working Criteria	• Too broad, not specific objectives. • Few criteria. • Contradictory, incomplete, or confused criteria.	• Somewhat specific, but not clear objectives. • Several criteria. • Some criteria detailed, but missed one or more criteria.	• Clear, explicit and measurable objectives. • Many criteria. • Complete and logical criteria clearly detailing problem.	
Research Sources	• Report only one source, or few sources of one type. • Reported irrelevant or not credible sources.	• Reports only a few sources (of few types). • Most sources are relevant and credible, but not all.	• Report many sources (of varying types). • Sources are relevant and credible.	
Summarize Research Findings	• Lack of or poor summary.	• Summary too broad, not precise, or some irrelevant statements.	• Summary is accurate, precise, and relevant.	
Project Management: Team	• Lack of or poor description of team structure and/or team leadership model. • Lack of or poor description of scheduling and tasks.	• Describes some but not all aspects of team structure and/or team leadership model. • Incomplete description of scheduling and tasks.	• Clearly and completely describes team structure, and team leadership model. • Clearly and completely describe issues related to scheduling and completion of tasks.	
Project Management: Resources	• Poor description of acquisition of materials, tools, and other resources required. • Lack of or sketchy budget included.	• Description of the acquisition of materials, tools, and other resources required is missing some details. • Budget includes some details, but is not complete.	• Clearly and completely describe the acquisition of materials, tools, and other resources required. • Detailed budget included.	

Identification of Feasible Alternatives	• One idea identified. • Process to identify alternative designs not described. • Minimal connection between research and alternatives identified.	• Few or very similar ideas identified. • Process to identify alternative designs not fully described. • Refers to research, but connection between research and alternatives not established.	• Multiple ideas of different types identified. • Process to identify alternative designs fully described. • Alternatives clearly based on research.	
Analytical Method	• Did not use math, physics or other science to examine problem • Did not incorporate a spreadsheet to illustrate analysis	• Used a math, physics or other science, but did not explain well how it related to the problem • Incorporated a poor example of the principle with a spreadsheet	• Explained well how math, physics or other science principles were appropriate to problem • Used the spreadsheet to show a good example of this principles relationship to problem	
Selection and Analysis of Alternatives	• Process is not described. • No evidence of planning. • No decision. • No connection between analysis and working criteria.	• Process is not fully described. • Some evidence of planning. • Two alternatives chosen. • Some connection between analysis and working criteria, but unclear	• Clearly explains process for narrowing number of alternatives. • One alternative chosen. • Clear and documented connection between analysis and working criteria.	
Develop Project	• Description of construction lacks detail. Not replicable.	• Detailed description of construction but lacks some key details.	• Detailed description of construction. • Clear step-by-step description. • Can be replicated.	
Project Testing	• Limited or no testing described. • No description of what worked and what did not work and why	• Confused or only one type of test described. • Described partly what worked but not all details about what worked, did not work and why	• Multiple types of testing. • Described well what worked and what did not work and why	

Analysis of Results	• No summary of final design. • Limited strengths and weaknesses outlined. • Does not explain how results compared to original design	• Final design explained. • Emphasis on strengths or weaknesses, but not both. • Does not explain well how results compared to original design	• Key components of final design are detailed. • Both strengths and weaknesses detailed. • Explained well how results compared to original design	
Conclusion	• No lessons learned summarized. • Does not explain whether project met design objectives.	• Few lessons learned are outlined, but are not tied to specific aspects of the project or research. • Summarization is unclear and/or disorganized. • Little attempt to describe whether project met design objectives.	• Lessons learned both positive and negative are outlined, and are tied to specific aspects of the process or research. • Summarization is clear, organized and the degree to which project met design objectives is clearly and completely explained.	
Team Charter	• No attempt to follow team charter outline.	• Follows team charter outline incompletely.	• Follows team charter outline completely and accurately.	
Project Schedule	• Tasks and deadlines are not synchronized.	• Tasks are not adequately delineated. • Some deadlines are reasonable.	• Detailed task statements and reasonable deadlines.	
Design Drawings	• No design solution, or draws solution which is unsupported by design needs.	• Drawing is incomplete or inaccurate.	• Draws accurate solutions supported by design needs.	
Overall Design Process	• Paper shows students did not follow or did not understand the design process.	• Paper shows students understood most but not all steps in design process.	• Paper show students clearly understood and used the design process.	
Focus and Flow of Paper	• No transition between sections. • Organization within most sections lacks coherence; ideas not clear; and writing not focused.	• Some transition between sections. • Writing clear in some sections, but not all, and some sections are focused, but others ramble.	• Transition between sections is clear and natural. • Organization of ideas within all sections and between sections is clear. • Within sections writing is focused and supportive.	

Structure	• Does not follow outline given.	• Missed some of sections outlined.	• Each section is clearly delineated from the others and follows the outline given.	
Style	• Sentence structure is too simple or monotonous and does not place emphasis on important ideas; word choice is clichéd, dull, inconsistent, or unsuitable to audience or purpose.	• Sentences are clear and incorporate proper emphasis; they are written at a level appropriate to the audience; word choice is suitable to the audience and purpose and avoids wordiness and redundancy.	• Sentence structure is varied and highly readable; the choice of words is fresh and interesting, making the ideas memorable and powerful.	
Grammar	• The kind and number of grammatical and mechanical errors seriously impede the progress of the reader and undermine the credibility of the writer. • Sources are documented inadequately.	• Reader is not impeded by grammatical and mechanical errors. • Writing demonstrates general mastery of Standard Written English. • Sources are documented adequately, using a documentation that is appropriate to the audience	• Writing has virtually no problems with grammar or mechanics, demonstrating a mature command of Standard Written English.	
			TOTAL	

Developed by Spurlin, Robbins, Lavelle, NCSU, College of Engineering; Fall 2002

Appendix B
Grading Rubric for Oral Presentations, Fall 2002

Dimension	Poor (1 point)	Average (2 points)	Excellent (3 points)	Points

Organization	• Sequence of information is difficult to follow. • Lacks beginning or ending or beginning or ending inappropriate. • Does not move smoothly from one idea to the next.	• Student presents information in logical sequence which audience can follow. • Uses an appropriate beginning or ending. • Moves smoothly from one idea to the next some of the time.	• Information in logical, interesting sequence which audience can follow. • Uses an engaging beginning and/or thoughtful ending. • Moves smoothly from one idea to the next all of the time.	
Content Knowledge	• Student does not have grasp of information. • Cannot answer questions. • Information included is sufficiently inaccurate that the listener cannot depend on the presentation as a source of accurate information.	• Student is able to demonstrate basic concepts. • Can answer questions, but not fully. • Enough errors are made to distract a knowledgeable listener, but some information is accurate.	• Student demonstrates full knowledge. • Can answer questions fully and accurately. • Information is correct and accurate	
Grammar and Spelling	• Presentation has three or more spelling and/or grammatical errors.	• Presentation has no more than two misspellings and/or grammatical errors.	• Presentation has no misspellings or grammatical errors.	
Style	• Level of presentation is too elementary or too sophisticated. • Superfluous graphics or no graphics.	• Level of presentation is generally appropriate. • Graphics relate to text and presentation, and contribute to the quality of the presentation. • Some material may not be supported by visual aids.	• Level of presentation is appropriate to the audience. • Graphics explain and reinforce screen text, and enhance the presentation.	
Visual Impact of Slides	• Font is too small to be easily seen. • Too much information is included. • Unimportant information is highlighted.	• Font is appropriate for reading but could be larger for better presentation • Most of the information is appropriate. • Unimportant information or too much detail was included	• Font is large enough to be seen by all. • Details are minimized so that main points stand out. • No unimportant information was included	

Professionalism	• Personal appearance is inappropriate for the occasion and audience. • No members of the team were on time. • The team members handled any technical difficulties unprofessionally.	• Personal appearance is somewhat inappropriate for the occasion and audience. • One member of the team was not on time. • The team members handled some part of the presentation unprofessionally.	• Personal appearance is completely appropriate for the occasion and the audience • All members of the team were ready on time. • The team members handled the entire presentation professionally, even if there were technical difficulties.	
Presentation Style	• Listeners are so distracted by the presenter's apparent difficulty with presentation that they cannot focus on the ideas presented. • Read notes or slides and did not look away from notes or slides	• Listeners can follow the presentation, but some difficulty in presentation is distracting from ideas presented. • Read some notes or slides but also looked away from notes and slides	• Listeners are captivated by the presentation and are very focused on ideas presented • Referred to notes or slides but did not read notes or slides	
Delivery	• Body language shows obvious nervous tension. • No effort to make eye contact. • Monotone voice.	• Body language shows some nervous tension. • Occasional unsustained eye contact. • Voice with some inflection.	• Body language is relaxed. • Consistent eye contact. • Voice is clear with interesting modulation.	
Transition Between Speakers	• Transition between speakers was awkward and unprofessional	• There was some awkwardness when transitioning between speakers but some was smooth and professional	• Transition between speakers was smooth and professional	
Timeliness	• Entire presentation was 5 minutes, or more, over or under allotted time	• Entire presentation was within 2-5 minutes of allotted time	• Entire presentation was within 2 minutes of allotted time	
			TOTAL	

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Appendix C
Teamwork Rubric, Fall 2002

Use the following criteria as the basis for evaluating yourself and your team members on a scale of 1 (low) to 5 (high) according to the rubrics in the table below.

CRITERIA		RANK	DESCRIPTION
I	Share of tasks assumed	**5**	Did fair share of work
		4	Did almost fair share but one or two times slacked-off or took too much on
		3	Did average amount of work but could have done more
		2	Did less work than average for the team or did a much larger share of team work than average
		1	Did little, almost no work or did all the work
II	Contribution and Quality of Work	**5**	Contributed far beyond average to the team discussions, and decisions; contribution was of high quality
		4	Contributions were a major portion of the team discussions, and decisions; contribution was of good quality
		3	Made valuable contributions to team discussions, and decisions; contribution was of good quality
		2	Occasional contribution to team discussions, and decisions; contribution was of poor quality
		1	Made little contribution to team discussions, and decisions; contribution was of poor quality
III	Team Spirit	**5**	Exceptionally helpful, respectful, and considerate of other team members
		4	Better than most in being helpful, respectful, and considerate of other team members
		3	Respected team members, considerate, cooperative
		2	Contributed to team effort, but not committed to team building; sometimes impatient, disrespectful, or inconsiderate of team members
		1	Removed from commitment to the team effort, or overbearing and inconsiderate of team members
IV	Dependability	**5**	Exceptionally dependable; always attended meetings on time; fully prepared
		4	Better than most in dependability, punctuality, and preparedness
		3	Dependable; attended most team meetings; generally punctual and well prepared
		2	Dependability unpredictable; sometimes skipped team meetings or arrived late; not always well prepared
		1	Unreliable; skipped many meetings or arrived late; generally poorly prepared
V	Communication	**5**	Always listens and speaks appropriately; never argues inappropriately with teammates

		4	Most of the time listens and speaks appropriately, mostly arguments are appropriate
		3	Sometimes listens and sometimes talks too much or too little; sometimes argues inappropriately
		2	Most of the time talks to much or listens too little; most of the time arguments are inappropriate
		1	Team member continuously talking or never talks or argues inappropriately with teammates
VI	Over all eval uatio n	**5**	Outstanding: I would work with this person again
		4	Very good: I probably would work with this person again
		3	Good: I might work with this person again, but I might not
		2	Fair: I probably would not work with this person again
		1	Poor: I would not work with this person again

Teamwork Rubric modified from rubric found on website:
http://www-geology.ucdavis.edu/~hnr094/HNR_094_PeerEval.html.
Robert J. Twiss, HNR 094-5: Science and Pseudo-Science, Davis Honors Challenge, University of California-Davis, Spring 1997.

Appendix D
Course Evaluation Survey, Fall 2002
E101 Course Evaluation Form

Instructor's Name: ______________________________ E101 Section No. ___________________

Please rate each item on a scale of 1 (Little) to 5 (Alot); Degree to which you have learned about the following during E101 course:

	Little				**A Lot**
1. Engineering Design Process	1	2	3	4	5
2. Engineering as a professional field	1	2	3	4	5
3. The various engineering disciplines	1	2	3	4	5
4. Current events in the engineering disciplines	1	2	3	4	5
5. Working on Teams	1	2	3	4	5
6. Understanding the Importance of Teams	1	2	3	4	5
7. Project Scheduling/ Documentation	1	2	3	4	5
8. Failure in Engineering Design	1	2	3	4	5
9. Written Communication in Engineering	1	2	3	4	5

10. Oral Communication in Engineering	1	2	3	4	5
11. Engineering Ethics	1	2	3	4	5
12. Personal/Professional Development	1	2	3	4	5

Overall, the quality of each of the informational sessions I attended was:

	Low		**……….Medium…….**		**High**	**Did not Attend**
13. Biological Engineering	1	2	3	4	5	0
14. Biomedical Engineering	1	2	3	4	5	0
15. Chemical Engineering	1	2	3	4	5	0
16. Civil Engineering	1	2	3	4	5	0
17. Construction Engineering and Management	1	2	3	4	5	0
18. Environmental Engineering	1	2	3	4	5	0
19. Computer Science	1	2	3	4	5	0
20. Electrical Engineering	1	2	3	4	5	0
21. Computer Engineering	1	2	3	4	5	0
22. Industrial Engineering	1	2	3	4	5	0
23. Materials Science and Engineering	1	2	3	4	5	0
24. Mechanical and Aerospace Engineering	1	2	3	4	5	0
25. Nuclear Engineering	1	2	3	4	5	0

If your rating of any Informational Session was 1 or 2, please explain that rating:

____

____

(OVER)

In the context of the entire course, my overall rating of each item below is:

	Low		**………Medium…..…**		**High**	**Not Applicable**
26. Course Instructor	1	2	3	4	5	0
27. Course SEL (TA)	1	2	3	4	5	0
28. The physical classroom facilities	1	2	3	4	5	0
29. The computer facilities	1	2	3	4	5	0
30. College of Engineering Welcome	1	2	3	4	5	0
31. Engineering Librarian Presentation	1	2	3	4	5	0
32. Goal Setting Assignment	1	2	3	4	5	0
33. Resume Assignment	1	2	3	4	5	0
34. Team Presentation on Degree Program	1	2	3	4	5	0
35. Straw Dome Project	1	2	3	4	5	0

36. Exam	1	2	3	4	5	0
37. Journals	1	2	3	4	5	0
38. Surveys	1	2	3	4	5	0
39. Design Project	1	2	3	4	5	0
40. Design Project Day (FEDD)	1	2	3	4	5	0
41. Entire Course	1	2	3	4	5	0

Written Comments:
We highly encourage you to take the time to complete the section below where we are asking for your written feedback on the course. This course is very important to all in the college, and we need your feedback to help us to continue making the course the best that it can be. Thanks for your feedback!

Think about the overall course and its learning objectives, and please offer written comments on the course. Provide details on things that you liked and did not like, as well as things that you thought went well and things that can be improved (describe how to improve if you have any ideas). In making your comments, please think about the course syllabus, the instructor and instruction in general, the schedule, the SEL, the facilities, resources and anything else. Thank you again for your valuable feedback. We look forward to serving you and to your continued success in the College of Engineering.

Developed by Lavelle, Spurlin, NCSU, College of Engineering, Fall 2002