Incorporating the Design and Use of Surveys with Other Engineering Assessment Methods under Criteria 2000 Guidelines

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Abstract

Student surveys, including course evaluations, exit surveys, and alumni surveys, continue to provide a valuable means of evaluating engineering curricula. Under the new ABET Engineering Criteria 2000 assessment guidelines, each engineering program must demonstrate achievement in a number of "program outcomes", determined by both the accreditation board (Criteria 3 and 8), as well as the institution. Each engineering program must therefore establish an effective assessment mechanism that directly addresses these desired program outcomes. In addition to providing a technique to measure achievement in the program outcomes, this assessment mechanism must also incorporate its results in a continuous feedback cycle, designed to improve program effectiveness. Student surveys play an important role in this feedback process. For maximum correlation to other assessment processes, these surveys must directly address student perception of individual opportunities and achievement in each of the desired program outcomes. This requires that the students be informed of how these program outcomes are incorporated into their graded assignments in each course. This paper discusses the design of student surveys (course evaluations, exit surveys, and alumni surveys) to interface directly with a novel program assessment mechanism. This mechanism consists of an assignment database with individual assignment records contributed by the faculty for each course. The assignment database contains faculty estimates of assessment data regarding which program outcomes are addressed and the extent to which they are addressed by each assignment. Further, each database record includes student performance data for the assignment. Independently, neither the assignment database nor the survey data provide a complete self-validating source of assessment data for the program. However, when utilized together these two sources of assessment data can be used to support inferences and conclusions, provide mutual validation, and help resolve conflicting inferences from the two data sources in providing guidance for feedback to the curricula. Specifically, students' perception of their performance regarding a specific program outcome as shown in the survey results may not be an accurate reflection of their actual performance as shown in the database records. Likewise, faculty perceptions and intentions regarding the quantity and quality of opportunities afforded to the students to engage in activities related to acquiring the skills associated with the programs outcomes must be apparent to the students in order to achieve the desired results of the program. Thus, with proper survey design and implementation, the survey results and database records will complement each other. Feedback from each of these two assessment processes will therefore allow the faculty to more efficiently revise course presentation and/or assignment content, in order to provide the

continuous program improvement stressed by the accreditation board. The following sections outline the design of these surveys, some initial results, the interaction of the surveys with program assessment data gathered and compiled in the database, and examples of program changes that have resulted from the feedback process.

Introduction

The transition to ABET Criteria 2000 denotes a shift from the traditional quantitative analysis of an engineering program's curriculum (sometimes referred to as "bean-counting") towards a more outcome-based evaluation procedure. Thus, as engineering programs around the country prepare for their first accreditation under the new guidelines, the development of an effective assessment mechanism is becoming an increasingly vital concern.[1-7]

The nature of Criteria 2000 provides each engineering program with the flexibility it needs in order to develop and maintain a quality curriculum, regardless of the constraints or limitations of its environment, i.e. whether it operates within a doctoral-granting university or a small undergraduate college. Likewise, the same flexibility exists for each engineering program to develop an assessment mechanism that is suitable for its individual profile. A survey of recently published papers on ABET Criteria 2000 demonstrates the wide variety of techniques being utilized by engineering programs to address the assessment issue.[2-4, 8-16]

Outcome indicators are measurement instruments that are used to confirm achievement of a program's desired educational outcomes.[17] Selection of the appropriate outcome indicators for use in the collection and analysis of student performance data has been identified as a key element in the iterative process of developing and implementing a comprehensive assessment plan. In the implementation phase of the comprehensive assessment plan, the data gathered via outcome indicators are evaluated with respect to the program's intended outcomes, and interpreted to draw inferences and provide informed feedback to the constituents of the program.[18,19] Triangulation, or the use of multiple assessment methods, is an important consideration in the selection of a set of outcome indicators utilized by a comprehensive assessment plan.[18] At the Virginia Military Institute, triangulation is provided within the Electrical Engineering Department's assessment plan by the use of surveys and the department's course assignment database.

While the specific mechanisms and strategies of assessment vary from program to program, the use of surveys is a common approach. As outlined by Jennings and Anagnos[8], such surveys, regardless of their targeted constituents (students, alumni, etc.), must maintain the fine line of being both comprehensive and concise. The authors are also quick to point out the need for an automated system of compiling survey data, such as computer scanning. Thus, to be effective, surveys must be easy to use, and must be carefully designed to avoid unnecessary disruption within the program. In addition, ABET Criterion 3 explicitly requires the use of assessment feedback to effect program changes in a "continuous improvement" process. Thus, surveys must also be easy to alter, as necessary, to reflect any resulting changes in the engineering program.[8-10]

Another component of our assessment mechanism is the assignment database. The database records detail the faculty perceptions and intentions regarding which, if any, of the program's 16 desired outcomes are addressed by each course assignment and the extent to which they are addressed. Additionally, each assignment database record contains actual student performance data in the form of the average grade achieved on the assignment.[11] To provide comparable assessment data from other constituents of the program, three surveys have been designed to gather student and alumni perception of how the various curricula (EE, non-EE, and co-curriculum) address the same 16 Program Outcomes. The survey results will be used in conjunction with the database information to provide feedback about the effectiveness of the program, so that informative decisions may be made regarding any necessary changes to the program.

Survey Design and Implementation

Three surveys are being used within our assessment framework : a semester survey, an exit survey, and an alumni survey. All three surveys reflect a similar design in order to develop and maintain a familiarity with the students and alumni. This similarity will also make it easier to compare and contrast data from the surveys, as well as from the database records. In addition, all surveys are designed to be computer scanned, which will aid in the gathering and manipulation of the data.

The semester survey is designed to procure data from individual courses. Specifically, the students are questioned regarding their acquisition of skills associated with the 16 Electrical Engineering Educational Outcomes listed below :

Defined by ABET : (items 1-13)
"General Criteria" (Criterion 3)

1. An ability to apply knowledge of math, science, and engineering
2. An ability to design and conduct experiments, as well as to analyze and interpret data
3. An ability to design a system, component or process to meet desired needs
4. An ability to function on multi-disciplinary teams
5. An ability to identify, formulate, and solve engineering problems
6. An understanding of professional and ethical responsibility
7. An ability to communicate effectively
8. The broad education necessary to understand the impact of engineering solutions in a global and societal context
9. A recognition of the need for, and ability to engage in life-long learning
10. A knowledge of contemporary issues
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

"Program Criteria" (Criterion 8)

12. A knowledge of probability and statistics, including applications appropriate to electrical engineering
13. A knowledge of advanced mathematics, typically including differential equations, linear algebra, complex variables, and discrete math

Defined by VMI EE : (items 14-16)

14. An ability to acquire new information, assimilate that information into a body of knowledge and apply that knowledge to the solution of problems

15. An ability to function as a member of a team in project design and laboratory experiment environments
16. An ability to apply contemporary analytic, computational and experimental practices in the laboratory environment

In particular, the students are asked to rate their **opportunity** to engage in these skills, both **quantitatively** and **qualitatively**, (i.e. how *man*y opportunities were available for skill-development, and were the opportunities *helpful* in developing these skills) as well as their perception of their **achievement** in acquiring these skills. The survey asks the students to rate these three items for each of the EE classes they are taking that semester. The importance of distinguishing both quantity and quality of opportunity from level of achievement has previously been addressed by Enbody.[12] However, since some of the outcomes may be met by activity outside of Electrical Engineering, the survey also asks them to evaluate all of their **non-EE classes,** and the unique VMI **co-curriculum** system during the semester. This need to include such external factors, such as service courses and co-curricular activities in the assessment process has also been addressed at other institutions.[8,13] A copy of the VMI Electrical Engineering Semester Survey is included as Appendix A.

One of the deficiencies of our assessment mechanism, discovered in the early stages of the database record development, was the students' unfamiliarity with the desired 16 Program Outcomes listed above.[11] This was corrected by providing the students with a handout at the beginning of the semester that described the 16 Outcomes. In addition, a system was adopted where the faculty would provide the students with a component of the database records that demonstrated the instructor's perception and intentions regarding which of the 16 Educational Outcomes were addressed in each assignment, as well as to what extent each outcome was applicable. This typically took the form of a small table, appearing at the top of each assignment, showing each of the 16 Outcomes and the relative importance of each (on a scale of 0 (lowest) to 5 (highest)) (Figure 1). Note that this approach provides immediate feedback to the students, in that when the graded assignments are returned to the students, they are able to attribute deficiencies in their performance to particular outcomes, and effect appropriate improvements.

EE 101
Breadboard and Spreadsheet Exercise

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
4	4	2	0	5	1	3	1	1	1	5	1	0	4	4	4

Figure 1 Extent of Outcome Application in Assignment

The exit survey is designed to gather information regarding students' perceptions of their entire Electrical Engineering program. This data will be useful in that a comparison may be made between first-year students and final-year students. In general, this survey will allow the tracking of students' perceptions of learning throughout their program of study. A similar assessment has been performed elsewhere, comparing student performance at the beginning and end of a semester.[14]

Again, the students are asked to evaluate their opportunities (both quantitatively and qualitatively) to engage in skills associated with the 16 Educational Outcomes described earlier, as well as their achievement in each outcome, over their entire tenure within the Electrical Engineering program. However, the students are also asked to rate their overall opportunity to engage in, and their level of achievement in, seven VMI Educational Objectives that have been developed in accordance with ABET Criterion 2 and the mission of the Institute. It is important to note that these Objectives have also been linked with the 16 Outcomes (see Appendix B), thus allowing another means of identifying program strengths and weaknesses down to the course level, or even assignment level, through the use of the semester survey and database record results. Background information, such as demographic data, important to other accreditation processes, is also included within the exit survey. The differences between the exit survey and the semester survey are also illustrated in Appendix B.

The alumni survey is designed to question graduates on the effectiveness of the VMI Electrical Engineering program, in preparing them for their careers. The design of the alumni survey will be virtually identical to that of the exit survey. The demographic questions will be expanded to identify career paths, progress, time since graduation, etc. Nevertheless, the same 16 Outcomes and seven Objectives will again be addressed, now by individuals with a new perspective on their experience at VMI.

The use of alumni surveys for program assessment is not uncommon.[2,8,12,13,15] However, there remains a great deal of uncertainty regarding the timing of alumni surveys, i.e. what is too soon following graduation, and what is too long after graduation to achieve effective survey results. Currently, the Electrical Engineering Department at VMI is planning to issue an alumni survey to its graduates of the past decade every five years. Thus, our first survey will be sent out early in 1999 to all graduates dating back to the class of 1989. The next survey, released in early 2004, will be addressed to alumni from the classes of 1994-2003. This system will therefore provide continuous alumni feedback from individuals who are 1,2,3,…,10 years removed from graduation. For example the class of 1994 will be surveyed at 5 and 10 years following their graduation, the class of 1995 will be surveyed at 4 and 9 years after graduation, etc. Since a new survey will be released every five years, this will ensure a continuous update of data prior to each ABET visit.

As mentioned by Jennings and Anagnos[8], it is important to note that the data discussed in this paper is establishing a “baseline” to which future data will be compared. Such a baseline is vital to the success of this assessment mechanism, in that reference points must be established from which progress may be measured. These comparisons will provide the supporting evidence necessary to effect the appropriate improvements to the program over time.

Survey Results

The following charts provide a sample of the magnitude of data generated by the surveys, to date. Charts 1-3 represent results obtained from the Fall 1998 semester survey, while Chart 4 is derived from data obtained from the exit survey of Spring 1998. As mentioned earlier, the alumni survey will not be released until early 1999.

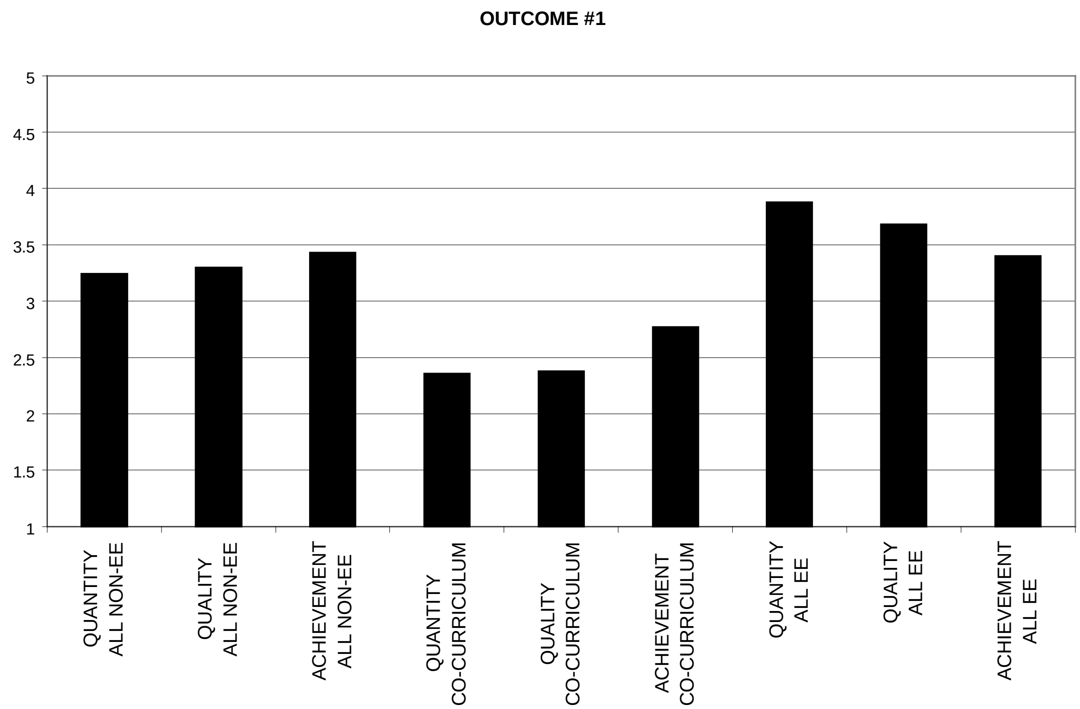


Chart 1

Chart 1 provides a summary of average student response to the first program outcome, "An ability to apply knowledge of math, science and engineering". Recall that students were asked to rate their opportunity to engage in skills associated with each outcome, both quantitatively and qualitatively on a scale of 1 (lowest) to 5 (highest). They were also asked to evaluate their achievement in such skills on the same scale. Not surprisingly, Chart 1 indicates that students felt that the EE curriculum provided more and better opportunities to develop math, science, and engineering skills, as compared to their non-EE and co-curricular activities. Likewise, the students' perception of achievement in these skills was higher within their EE and non-EE coursework, as compared to the co-curriculum.

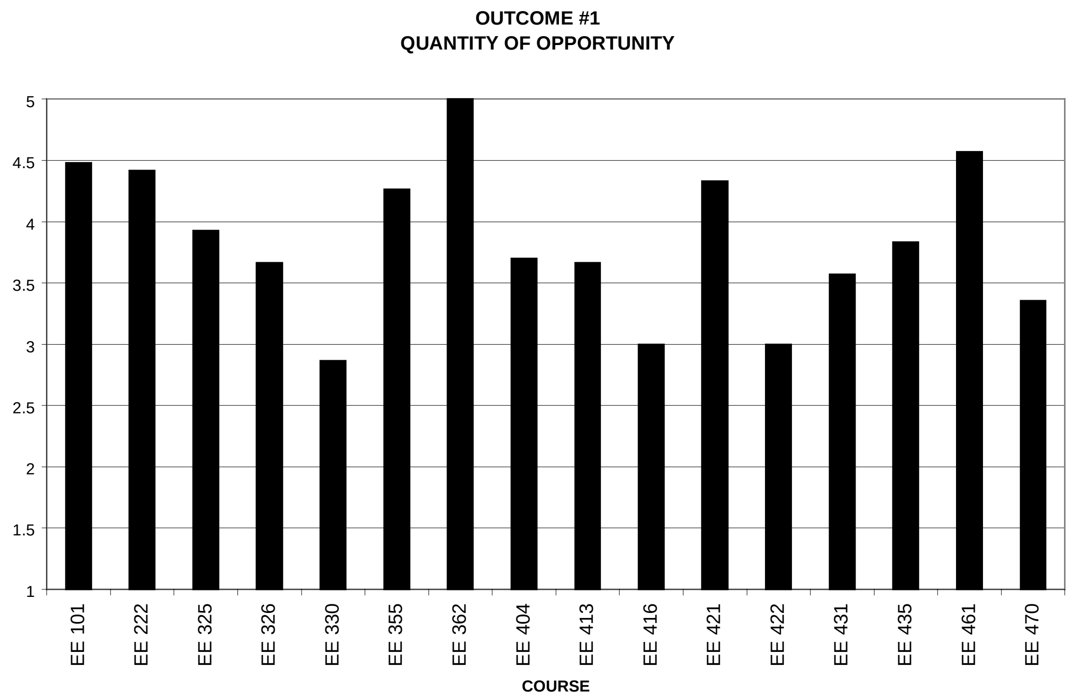


Chart 2

Chart 2 demonstrates how the semester survey data allow a comparison of results by course. This chart presents the students' perception of the quantity of opportunities to engage in math, science, and engineering skills (Outcome #1) for each course. This type of data will be particularly useful when compared to individual course data provided by faculty in the database records. Discrepancies between faculty opinion and student opinion regarding quantity and quality of opportunities provided may indicate a need to revise course material content and/or course presentation format.

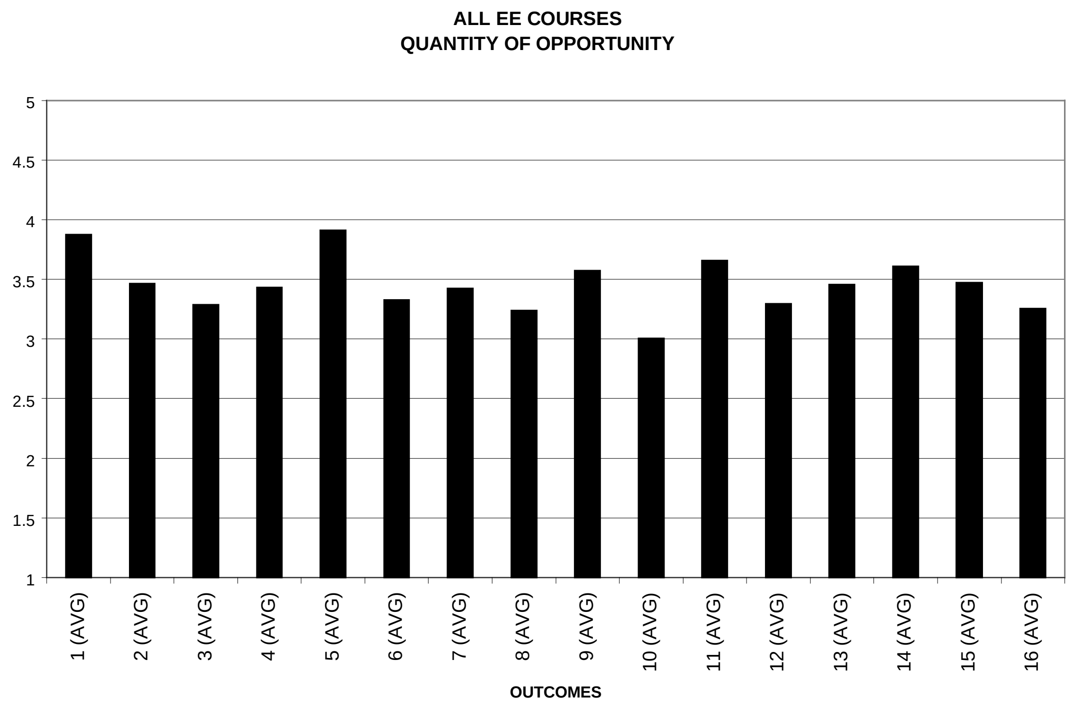


Chart 3

Chart 3 provides an overview of student perception regarding the quantity of opportunities to engage in skills associated with each of the 16 Program Outcomes, as provided by their EE courses. Again, when used with data from the database records, this data provides important feedback that can indicate any deficiencies within the program. Again, not surprisingly, the students felt that their EE curriculum provided the most opportunities to engage in the application of math, science, and engineering (Outcome #1), and to identify, formulate, and solve engineering problems (Outcome #5). The outcome rated lowest, yet still at an average level of 3, was a knowledge of contemporary issues (Outcome #10) – an outcome that has also received low ratings in other student surveys elsewhere.[16]

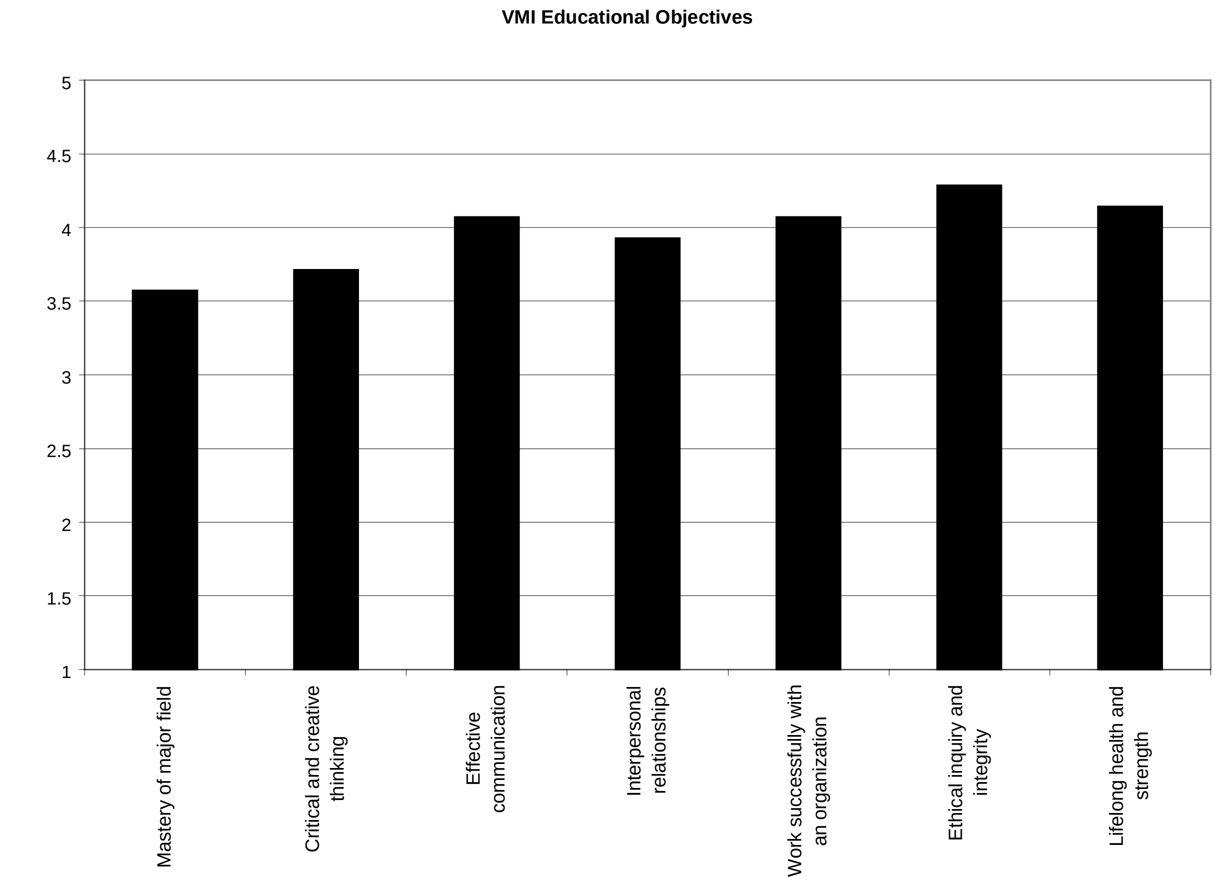


Chart 4

Chart 4 is an example of data obtained from the exit survey. In particular, the graph indicates the students' perception of their overall achievement in each of the seven VMI Educational Objectives outlined in Appendix B. This type of data provides direct feedback as to how well the Electrical Engineering program is supporting the mission of the Virginia Military Institute.

Course Assignment Database

The Electrical Engineering Department's course assignment database[11] contains one record for each graded assignment in all courses taught through the department to majors enrolled in the Electrical Engineering program at VMI. Each record is uniquely identified and formatted as shown in Figure 2.

ASSIGNMENT	Num.	Pts.	Ave.	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
EE431 Fall 1997 HW18	6	12	0.65	0.17	3		3		3						3		2	4		

KEYWORDS

digital filter design,bilinear transform,A/D-H(z)-D/A structure,plotting digital & analog frequency response

Figure 2 Course Assignment Database Record Format

The first field of the record is the key field that uniquely identifies the assignment by course, section, semester, year, and a descriptive label. Each record contains faculty estimates of which intended Educational Outcomes (1-16) are addressed and to what extent (0-5) they are addressed by the assignment. Assignment performance statistics and keywords are included as the remaining fields of each record. The number of students receiving a grade for the assignment, the number of points for the assignment, the average grade and standard deviation of the grades given for the assignment are the performance statistics provided for each assignment record. The keywords field is the last field in each record and provides a means to cross-reference assignments based on technical topical descriptors as well as by the educational outcomes addressed by the assignment.

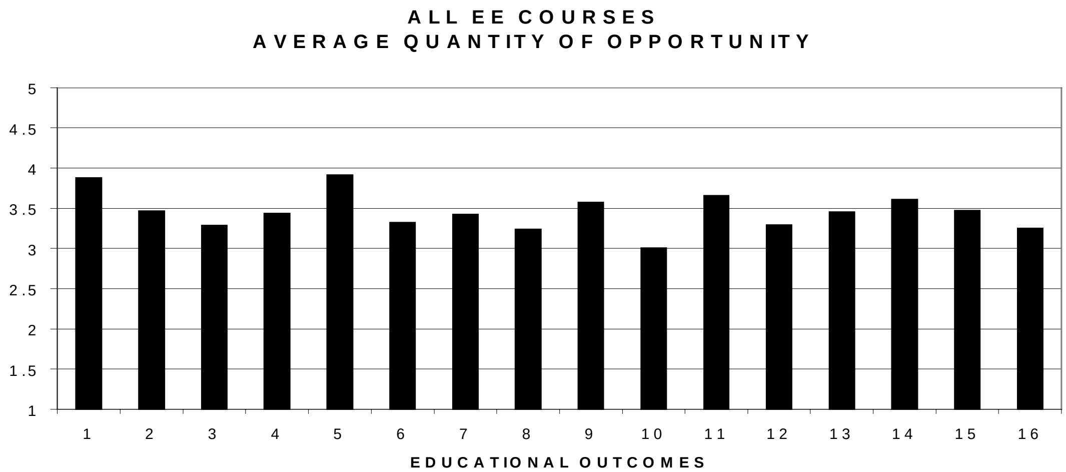
The detailed information provided and the capability to view assignments in terms of the intended educational outcomes across course boundaries make the database a potentially powerful and flexible outcome indicator.[11] The importance of assessment approaches embedded in the actual instruction delivery process is discussed by Ewell[20] in contrast with external outcome indicators such as the FE exam and other nationally normed test results that are not required for grade or certification. The advantages of assessment methods embedded in the instructional delivery process, such as the course assignment database, over nationally normed test results include a greater level of student motivation to perform well on the assignment since the students will be held accountable for their performance on the assignment. Also since the assignment has been related to the intended educational outcomes via the database record, the average grade and standard deviation of grades for the assignment offer a relative performance measure regarding the intended outcomes addressed by the assignment. Linkage of the assignment parameters as specified in the database record by the faculty is provided to the students in the course by including a portion of the database record information on the assignment sheet given to the students. This mechanism provides feedback to the students regarding their performance in achieving the intended educational outcomes addressed by the assignment. The overall collection of course assignment records can be utilized to provide feedback to the faculty, administration and accrediting agencies regarding the effectiveness of the program in achieving its specified intended educational outcomes and the corresponding broader educational objectives of the program. The assignment database utilizes data already collected as part of the course grading process and therefore adds little to the additional testing burden on the students imposed by external assessment tests. Ewell[20] concludes that embedded assessment methods may be the most important factor in keeping potentially burdensome assessment time and cost in check.

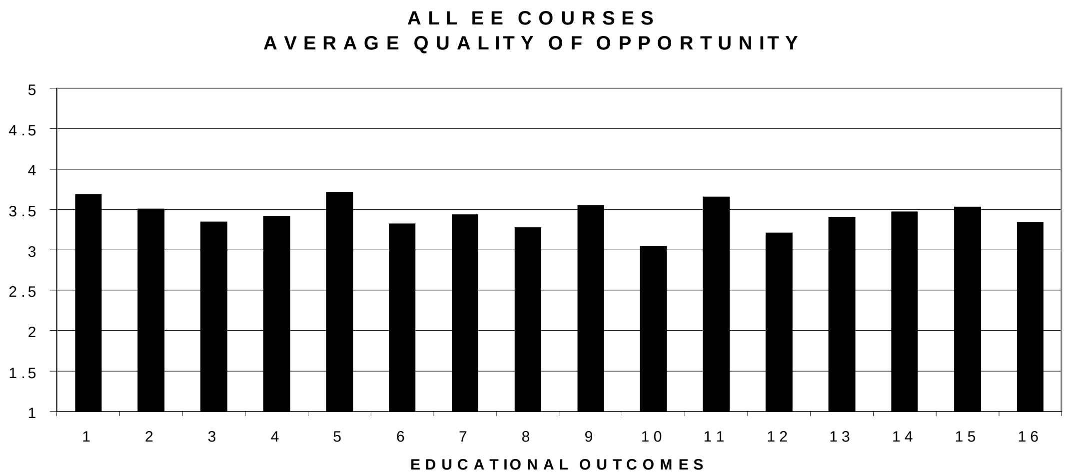
Comparison of Survey and Assignment Database Results

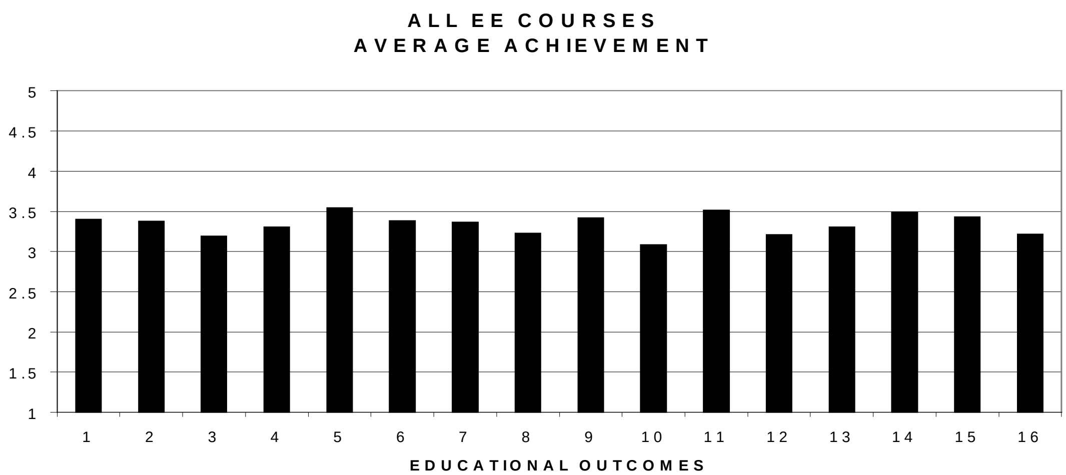
The combined use of surveys and the course assignment database provides multiple outcome indicators that offer a more flexible and potentially powerful set of assessment methods than either the surveys or the assignment database approach independently. Further, the very process of developing a comprehensive assessment plan, as noted by Olds[18], has already resulted in the faculty and the students becoming actively involved in the assessment process and thereby establishing a natural feedback linkage between the assessment methods utilized and the constituents of the program. The following comparison of some initial results from the student survey taken in the Fall 1998 semester and the course assignment database results for the 1997-

1998 academic year illustrates the potential use of these two outcome indicators in conjunction with each other. Figures 3 and 4 illustrate the survey and database results respectively regarding the quantity and quality of opportunities to engage in activities related to the intended Educational Outcomes (1-16) in graphs (A) and (B) for all Electrical Engineering courses. Graph (C) in each of the figures illustrates a measure of performance regarding the achievement of the 16 intended Educational Outcomes of the program. For all Electrical Engineering courses, student performance perceptions, regarding their achievement in attaining the intended outcomes, were obtained from the student end-of-course survey. Likewise, the actual performance results, in the form of the average grade on assignments related to each outcome, were obtained from the course assignment database. The student survey results were based only on the Fall Semester courses, whereas the database results utilized course assignment data records for all courses in the Electrical Engineering curriculum.

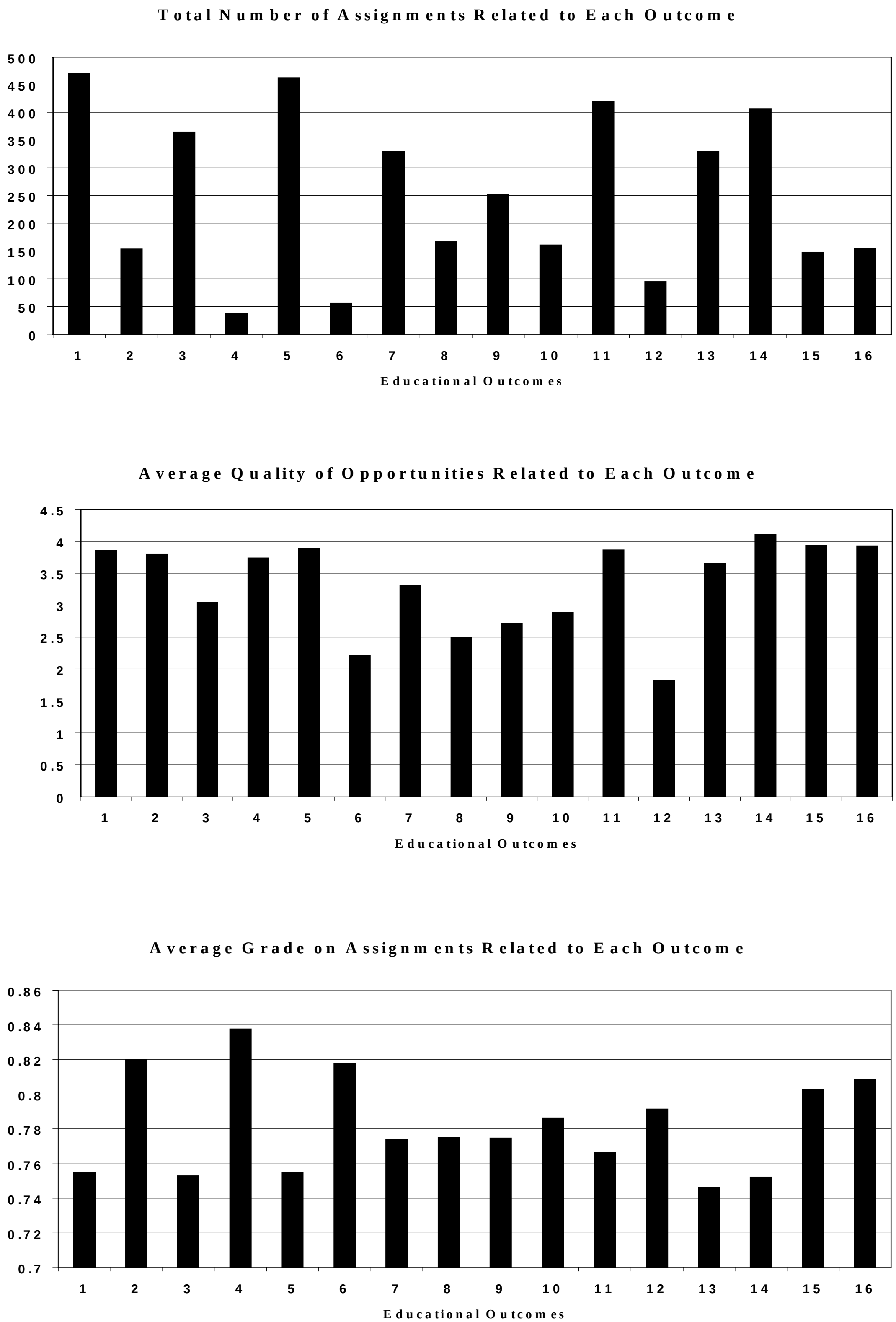
These initial student survey results are based on the responses of only one class of students and therefore any inferences drawn from them should take that factor into consideration. However, as more student survey data is gathered in future semesters, the reliability of the survey data and the strength of any inferences drawn from it would be expected to increase. Initially, it appears that the students' perception of the quantity of opportunities available to engage in activities related to each outcome, Figure 3 graph (A), is more uniformly distributed than the actual number of opportunities available throughout the curriculum, Figure 4 graph (A). For example, the students perceived that opportunities to engage in activities related to Educational Outcomes 4,6, and 12 were above average, while the actual data indicate that those educational outcomes are addressed in a much smaller proportion of the overall assignments. There may be several potential explanations for this difference, including the small survey results data set or a lack of common understanding between the faculty and the students regarding what these outcomes actually mean. Another apparent difference can be observed in the students' perception of their achievement regarding the 16 Outcomes and the actual achievement as measured by the average grade on assignments related to each educational outcome. The students' perceptions indicate that they feel that their achievement regarding the outcomes is more uniformly distributed than the actual average assignment results indicate. Investigating and resolving any apparent differences in the results obtained between these two outcome indicators offers a natural assessment feedback mechanism with input from the program's constituents. While the assignment database and student survey results for Electrical Engineering courses overall provide good baseline data against which individual course and individual assignments can be compared, the summative evaluation for each individual course related to each intended outcome offers an alternate view of the process. Figures 5 and 6 illustrate the student survey and assignment database results for individual courses related to Educational Outcome #1. Again, there are some apparent differences between the two outcome indicators regarding specific courses and the uniformity of the distribution between courses. This offers an opportunity to investigate and resolve these differences in a continual feedback cycle as part of the assessment process. While only the results relative to Outcome #1 are shown to illustrate the potential for using the outcome indicators, the assessment plan will evaluate each individual outcome in a similar manner to observe, analyze and evaluate the achievement of the program's intended educational outcomes, utilizing input from the program's constituents and feedback of the results to those constituents.



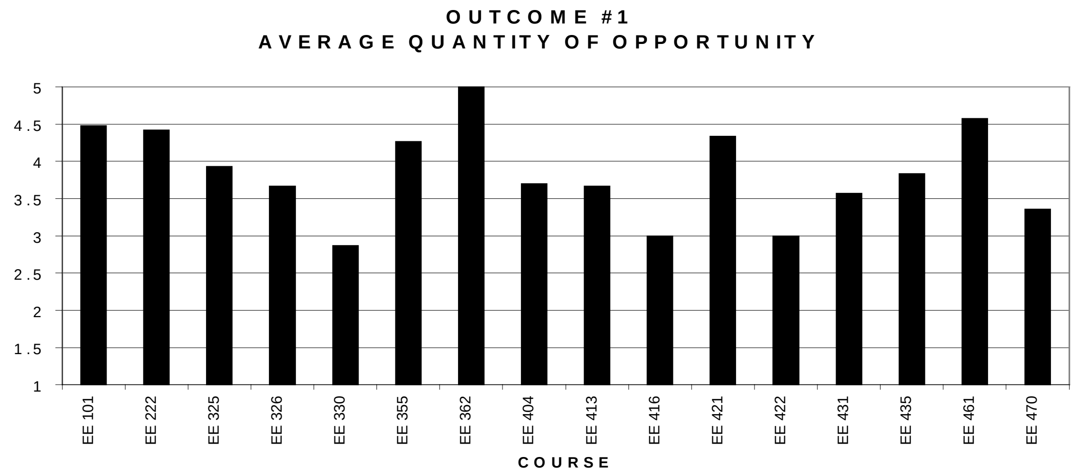


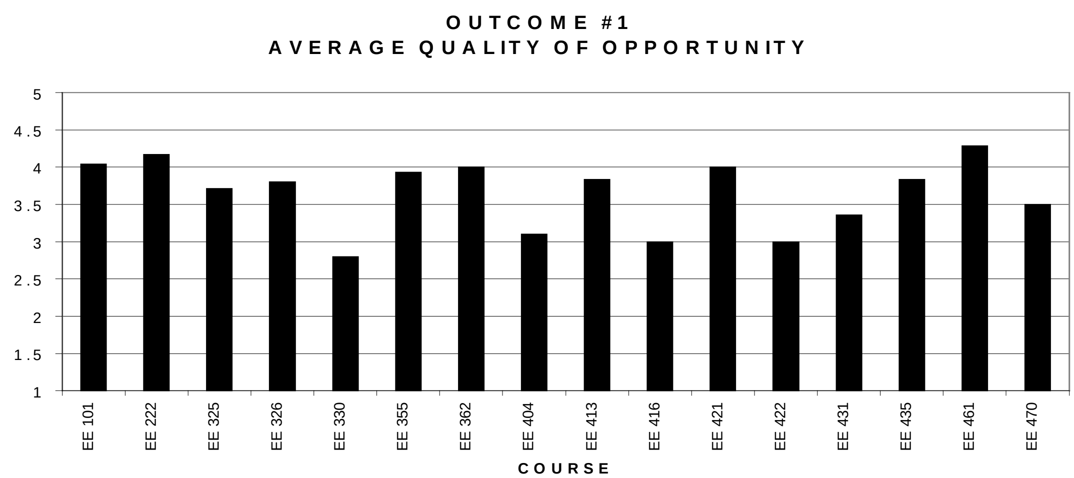


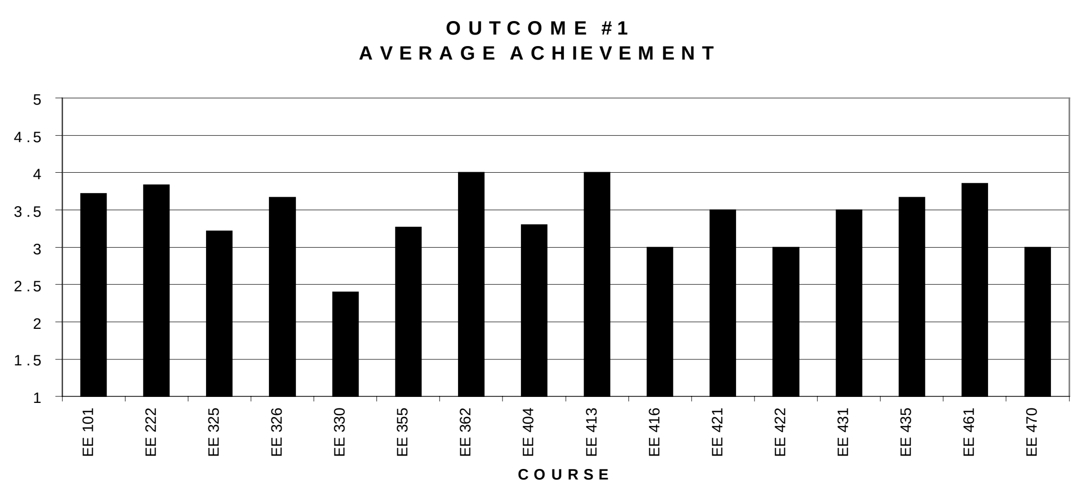
Figures 3 A, B, and C Student Survey Results for All EE Courses



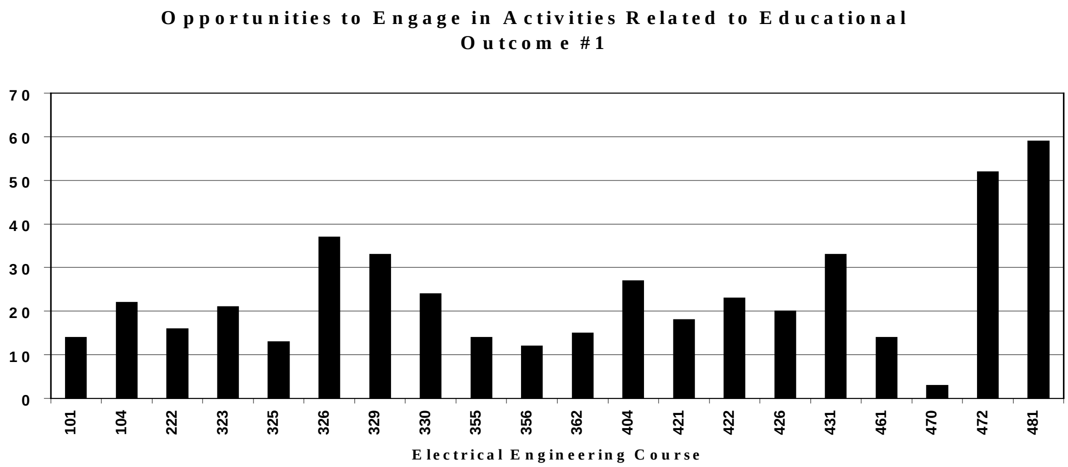
Figures 4 A, B, and C Assignment Database Results for All EE Courses

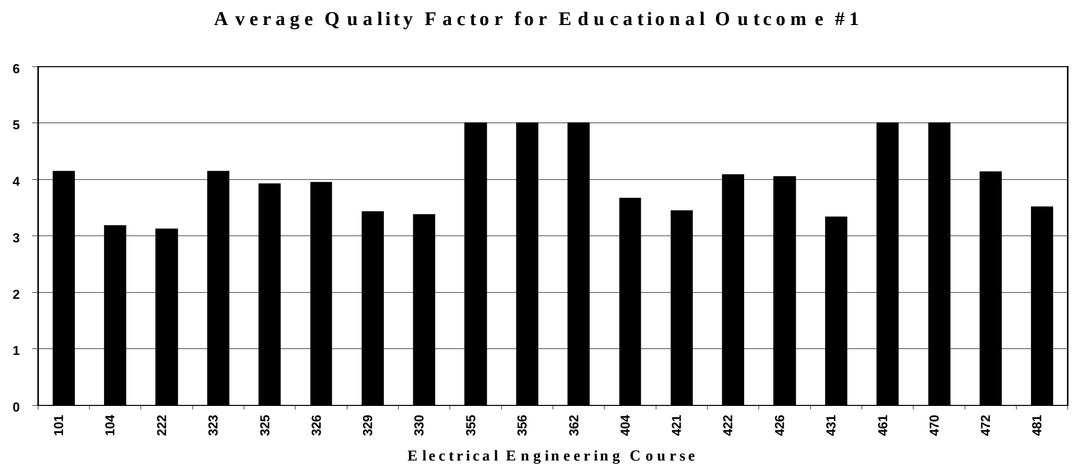


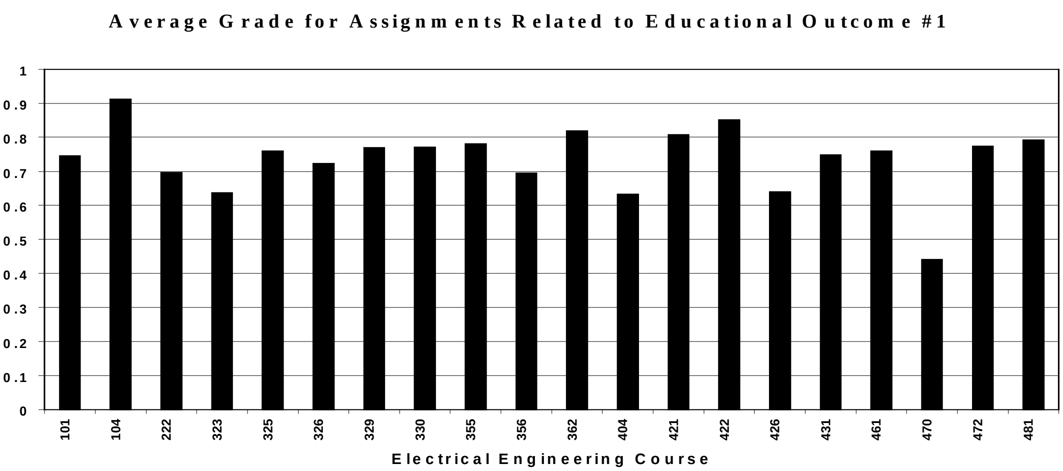




Figures 5 A, B, and C Student Survey Results for Educational Outcome #1







Figures 6 A, B, and C Assignment Database Results for Educational Outcome # 1

Conclusions

As noted by Watson, et al[5], it is important that an engineering program provide more than just a set of assessment data to an ABET evaluator. The engineering program must also establish a means of interpreting the data, and then applying the data towards the continual improvement of the overall program. The assessment mechanism developed by the Electrical Engineering program at the Virginia Military Institute is currently in the process of setting a baseline by which future data may be compared in order to make educated decisions regarding necessary program changes. The important concept of triangulation[18] has been implemented within our assessment mechanism through the use of various surveys (course evaluations, exit surveys, and alumni surveys), as well as the departmental database records. As has been observed by others,[7,11,12] there is a need to familiarize the constituents (students, alumni, etc.) of the educational system as to the desired program outcomes, as established by ABET and the individual program. In our case, this familiarization process has properly spread to the faculty. Through faculty interaction with the database records as well as the surveys, an enhanced faculty awareness of the desired seven Objectives and 16 Outcomes has been achieved. This, along with the preliminary results from the database records and the surveys, has already resulted in such changes as updated lecture and lab topics, revised homework and test problem formats, and adjustments to the departmental program of study. Both the database records system and the three surveys outlined in this paper are, by their very nature, flexible to the changes mentioned above. They too, will undergo necessary modifications in order to ensure the quality of education provided by our program is not only maintained, but refined.

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Appendix A

VIRGINIA MILITARY INSTITUTE

Electrical Engineering
Semester Survey

COURSE PREFIX NUMBER & SECTION							SEMESTER | YEAR	
A	A	0	0	0	0	0	Fall	0 0 0 0
B	B	1	1	1	1	1	Spring	1 1 1 1
C	C	2	2	2	2	2	Summer	2 2 2 2
D	D	3	3	3	3	3		3 3 3 3
E	E	4	4	4	4	4		4 4 4 4
F	F	5	5	5	5	5		5 5 5 5
G	G	6	6	6	6	6		6 6 6 6
H	H	7	7	7	7	7		7 7 7 7
I	I	8	8	8	8	8		8 8 8 8
J	J	9	9	9	9	9		9 9 9 9
K	K							
L	L							
M	M							
N	N							
O	O							
P	P							
Q	Q							
R	R							
S	S							
T	T							
U	U							
V	V							
W	W							
X	X							
Y	Y							
Z	Z							

Please rate your opportunity to engage in (both quantitatively and qualitatively), and your level of achievement in each objective on a scale from 1 (lowest) to 5 (highest).

		Quantity of Opportunity	Quality of Opportunity	Achievement
1. An ability to apply knowledge of math, science, and engineering				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
2. An ability to design and conduct experiments, as well as to analyze and interpret data				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3. An ability to design a system, component or process to meet desired needs				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

		Quantity of Opportunity	Quality of Opportunity	Achievement
4. An ability to function on multi-disciplinary teams				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
5. An ability to identify, formulate, and solve engineering problems				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
6. An understanding of professional and ethical responsibility				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
7. An ability to communicate effectively				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
8. The broad education necessary to understand the impact of engineering solutions in a global and societal context				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
9. A recognition of the need for, and ability to engage in life-long learning				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
10. A knowledge of contemporary issues				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
12. A knowledge of probability and statistics, including applications appropriate to electrical engineering				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
13. A knowledge of advanced mathematics, typically including diff. eqns., linear algebra, complex variables and discrete math				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

		Quantity of Opportunity	Quality of Opportunity	Achievement
14. An ability to acquire new information, assimilate that information into a body of knowledge and apply that knowledge to the solution of problems				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
15. An ability to function as a member of a team in project design and laboratory experiment environments				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
16. An ability to apply contemporary analytic, computational and experimental practices in the laboratory environment				
	this EE course	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	all non-EE courses	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	co-curriculum	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

Appendix B

VIRGINIA MILITARY INSTITUTE

Electrical Engineering
Exit Survey

A. BACKGROUND INFORMATION

RACIAL/ETHNIC DESIGNATION	GENDER	US CITIZEN	FINAL GPA RANGE
African-American/Black	Male	Yes	3.6-4.0
American Indian/Alaska Native	Female	No	3.0-3.5
Asian or Pacific Islander			2.5-2.9
Hispanic			2.0-2.4
White or Caucasian			Less than 2.0
Other			

POST GRADUATION PLANS
Graduate School
Industry
Military
Other

Please rate your opportunity to engage in, and your level of satisfaction with the following areas on a scale from 1 (lowest) to 5 (highest):

Opportunity		Satisfaction
1 2 3 4 5	Faculty/departmental advising	1 2 3 4 5
1 2 3 4 5	Internship/externship programs	1 2 3 4 5
1 2 3 4 5	Electrical engineering professional/honor society activities	1 2 3 4 5

B. Please rate your opportunity to engage in, and your level of achievement in the following VMI Educational Factors on a scale from 1 (lowest) to 5 (highest):

Opportunity		Achievement
1 2 3 4 5	Mastery of a major field of study	1 2 3 4 5
1 2 3 4 5	Ability to think critically and creatively	1 2 3 4 5
1 2 3 4 5	Ability to communicate effectively	1 2 3 4 5
1 2 3 4 5	Interpersonal relationship skills	1 2 3 4 5
1 2 3 4 5	Ability to work successfully within an organizational setting	1 2 3 4 5
1 2 3 4 5	Commitment to ethical inquiry and standards of integrity	1 2 3 4 5
1 2 3 4 5	Commitment to life-long physical health and strength	1 2 3 4 5

Relationship between VMI Educational Objectives and Program Outcomes

	EE PROGRAM EDUCATIONAL OUTCOMES																
VMI EDUCATIONAL OBJECTIVES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Mastery of a major field of study	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Ability to think critically and creatively	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
Ability to communicate effectively				X	X		X		X		X			X	X	X	
Skills in interpersonal relations		X	X	X	X	X	X								X	X	
Ability to work successfully within organizational setting		X	X	X			X		X					X	X	X	
Commitment to ethical inquiry and standards of integrity				X		X		X		X	X			X	X	X	
Commitment to life-long physical health and strength								X	X								

EE Program Educational Outcomes

1. An ability to apply knowledge of math, science, and engineering.
2. An ability to design and conduct experiments, as well as to analyze and interpret data.
3. An ability to design a system, component or process to meet desired needs.
4. An ability to function on multi-disciplinary teams.
5. An ability to identify, formulate, and solve engineering problems.
6. An understanding of professional and ethical responsibility.
7. An ability to communicate effectively.
8. The broad education necessary to understand the impact of engineering solutions in a global and societal context
9. A recognition of need for, and ability to engage in life-long learning.
10. A knowledge of contemporary issues.
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
12. A knowledge of probability and statistics, including applications appropriate to electrical engineering.
13. A knowledge of advanced mathematics, typically including differential equations, linear algebra, complex variables and discrete mathematics.
14. An ability to acquire new information, assimilate that information into a body of knowledge and apply that knowledge to the solution of problems.
15. An ability to function as a member of a team in project design and laboratory experiment environments.
16. An ability to apply contemporary analytic, computational and experimental practices in the laboratory environment.