2006-2270: A QUALITATIVE AND QUANTITATIVE EVALUATION TOOL FOR AN ELECTRICAL ENGINEERING LEARNING COMMUNITY

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Introduction

In the changing technological environment of the early 21st century, all technical and non-technical challenges appear to have multidimensional aspects. On the technical road to success, it is no longer sufficient to be able to solve isolated technological problems. The engineers and technologists of tomorrow need to be armed with the habits, problem-solving approaches, and learning capabilities that are far beyond any other time in human history. They need a dynamic *active-knowledge-base*, which includes an array of tools, concepts, critical thinking habits, team-building skills, and effective communication methods. The necessary *active-knowledge-base* is a moving target, rooted in the fundamentals of engineering and communication, and enhanced by a rate of change that is unprecedented in human history.

It is the authors' belief that the new age requires new ways of training. Engineers have to be problem solvers, team builders, and technological shape-shifters. They need to comprehend the advanced aspects of their areas of expertise. However, the knowledge of the facts and concepts are not sufficient. Their knowledge needs to be complimented by additional learning skills. They need to be lifelong learners in their respective fields. They also need to value the interdisciplinary understanding of the links between their field, other technical disciplines, and society. This challenge provides us with a unique opportunity to design, implement, and experiment with new ways of training and mentoring the engineers of tomorrow. The purpose of the Electrical Engineering Learning Community, EELC, is to provide an educationally nurturing environment to a group of freshmen and observe how such an enhanced environment helps them face challenges within their university experience. Currently a third of the freshman class is enrolled in this community. This effort has started in 2000 and has graduated the first team in 2005. The first year, there were approximately 25 students and thereafter 45 and above. This paper is based on research activities described in a dissertation by Richard Freeman entitled *Incorporating TQM and CQI techniques into Evaluation Tools for the Electrical and Computer Engineering Learning Communities*.

Learning communities are a concept that has existed, and been practiced, for many years. Since communities are normally viewed as groups of people that share some geographic, religious, professional, or common interests or identities, the thought of a community as a mechanism for teaching and learning, within an educational setting, seems strange. Prospective students and their families usually react positively when the concept is explained, with education, as the common interest. The term is used in multiple contexts today- describing learning communities as a single classroom or course, residence hall program, student-type or interest group, a thematic course of study, or virtual learning environment. [1,2] According to Lenning and Ebbers, learning communities are "an intentionally developed community that will promote and maximize learning". [3]

The evolution of learning communities, at Iowa State University, started in 1994. In the 2002-03 Academic Year, learning communities at Iowa State attracted 1,654 students, which represents 39.6% of the first year students. [4] An additional 485 students, identified as other than first year students, participated as well. Approximately 60.6% of first year engineering students participate in at least one learning community. [5]

Iowa State University, through its learning community initiative, has several subcommittees that enable learning community activities. These subcommittees include- Assessment, Curriculum Development and Enhancement, Peer Mentors, and Institute. The subcommittees focus on tasks necessary to create, maintain, and disseminate information about learning communities at Iowa State. Through these subcommittees, and links to key Iowa State University departments and offices, the learning community initiative can support multiple models.

EELC uses course clustering. Students participating in learning community are scheduled into a learning community section. The learning community section has a specific section of Mathematics (typically Calculus I and II), Science (Chemistry in the Fall Semester and Classical Physics for Engineers I in the Spring Semester), and a section of the learning community course (Engineering Problem Solving and Programming). EELC does not have the Living/Learning Option. The learning community has peer mentors that are usually chosen from previous learning community cohorts. These Peer Mentors work as additional Teaching Assistants in laboratory sections, social coordinators for activities, study group leaders for study groups, and mentors for class scheduling and overall university questions.

EELC engages in strong use of classroom assessment techniques but little formative or summative assessment. Assessment is a means of determining how well programs are achieving their desired goals. In the case of EELC, assessment can also provide useful feedback for improvement and data for future uses. How well EELC is performing, and can perform, can only be established by performing assessment.

As a university-approved learning community, EELC must perform an annual assessment. The primary reason for this assessment is to demonstrate the learning community is meeting its stated outcomes. There are three general reasons to assess any project or program- to improve the program or project; to inform stakeholders whether the program, or project, is achieving it's goals; or to prove a program, or project is meeting, or has met its intended goals. [6]

Traditionally, the evaluation in EELC is done via different tools. For the material at hand the evaluation has been done by homework, quizzes, tests, and laboratory reports. In addition to that, one-on-one interviews are conducted, with each student, twice during the term and would identify weakness and strengths for each student. The interview consists of the coordinator and the students during which the student would evaluate him or herself and together with the faculty coordinator would come up with plan of action to get more out of the learning community experience. During this meeting the faculty evaluator would evaluate students on their maturity, approach to learning, general attitude, and problem solving maturity. Finally the faculty coordinator would meet with the TAs and mentors and go over each student's growth and achievements. The EELC assessment has been based on the evaluation outlined above, and use of authentic assessment of an Electrical Engineering project (typically building a Ring Launcher, AM Radio, or other project that requires students to grasp several EE concepts) but is not a formal assessment program. Like other courses in the university, additional information is drawn from course surveys. What is not clear is whether, and how well, EELC provided students opportunities to achieve EELC stated outcomes. What has been clear from student behavior is that something is going well, but not what, or whether those effects can be attributed to EELC activities or general learning community environment.

Based on questions specific to the impact of the EELC, recommendations of the Learning Community Assessment Subcommittee, and university requirements for detailed assessment, a new assessment tool was created to address these needs.

The evaluation tool in figure 1 is designed to help the faculty gather assessment data throughout the year-long learning community courses, and make decisions based on an evaluation of that data. The assessment tool is designed to answer questions about how well these two learning communities are meeting their intended (stated) outcomes. The evaluation tool is a multi-step process. It is as much curricular design as assessment, and evaluation, of that curriculum. Hubba and Freed, Wiggins and McTighe, Rogers and Sando, Angelo and Cross, and others suggest that assessment should be planned as the course, or program, is being planned.

As previously defined, assessment is the process of gathering data used to make programming decisions. Assessment data can be either direct or indirect measures. The most common form of an indirect measure is student attitudes. Student attitudes do not measure how much, how well, or how deeply a student, or group of students has learned, but can measure the attitudes (thoughts, feelings, and metacognition) associated with that learning. In other words, a student may not perform very well on exams, quizzes and homework, but still be excited and motivated to work harder at learning a particular subject. Direct measures of assessment include exams, design projects, quizzes, reports, and homework. These measures involve the students in activities in which the student has to perform, or demonstrate, some skill.

Evaluation is the process of applying meaning to the assessment data, with the purpose of making decisions regarding the program. Following the tool, changes can be made to the learning communities' curricula that would easily allow the faculty to make subsequent changes to the assessment tools. The tool reflects the close relationship between assessment, outcomes and curriculum.

Faculty need to establish educational opportunities. Once a faculty member prioritizes knowledge and skills for the curriculum, she must create opportunities for students to learn them. Lectures, labs, homework, and student-led class discussions are examples of educational opportunities. In addition, Cooperative Learning exercises such as Jigsawing, and turn to your partner (TTYP) are also opportunities for students to learn from each other.

Faculty need to create assessment opportunities. Assessment of student learning and teaching should be continuous. Assessment should also include multiple measures and techniques to uncover learning and attitudes. Assessment opportunities are the key source of feedback from students in regard to their learning based on educational opportunities. Assessments can, and should, use both graded and non-graded items/techniques- Classroom Assessment Techniques (CATs), Continuous Quality Improvement (CQI) techniques, tests, quizzes, homework assignments, projects, and surveys can be incorporated into the assessment to help gather student data. By using graded materials, the faculty member is giving students feedback on their performance on expected tasks/skills. Students can then assess their course-related learning and skills, reactions to teaching and teacher, and course-related materials, activities, and environment. Some techniques require minimal planning, resources, time, and effort, while others require careful planning and extensive resources. A mix of assessment techniques allows

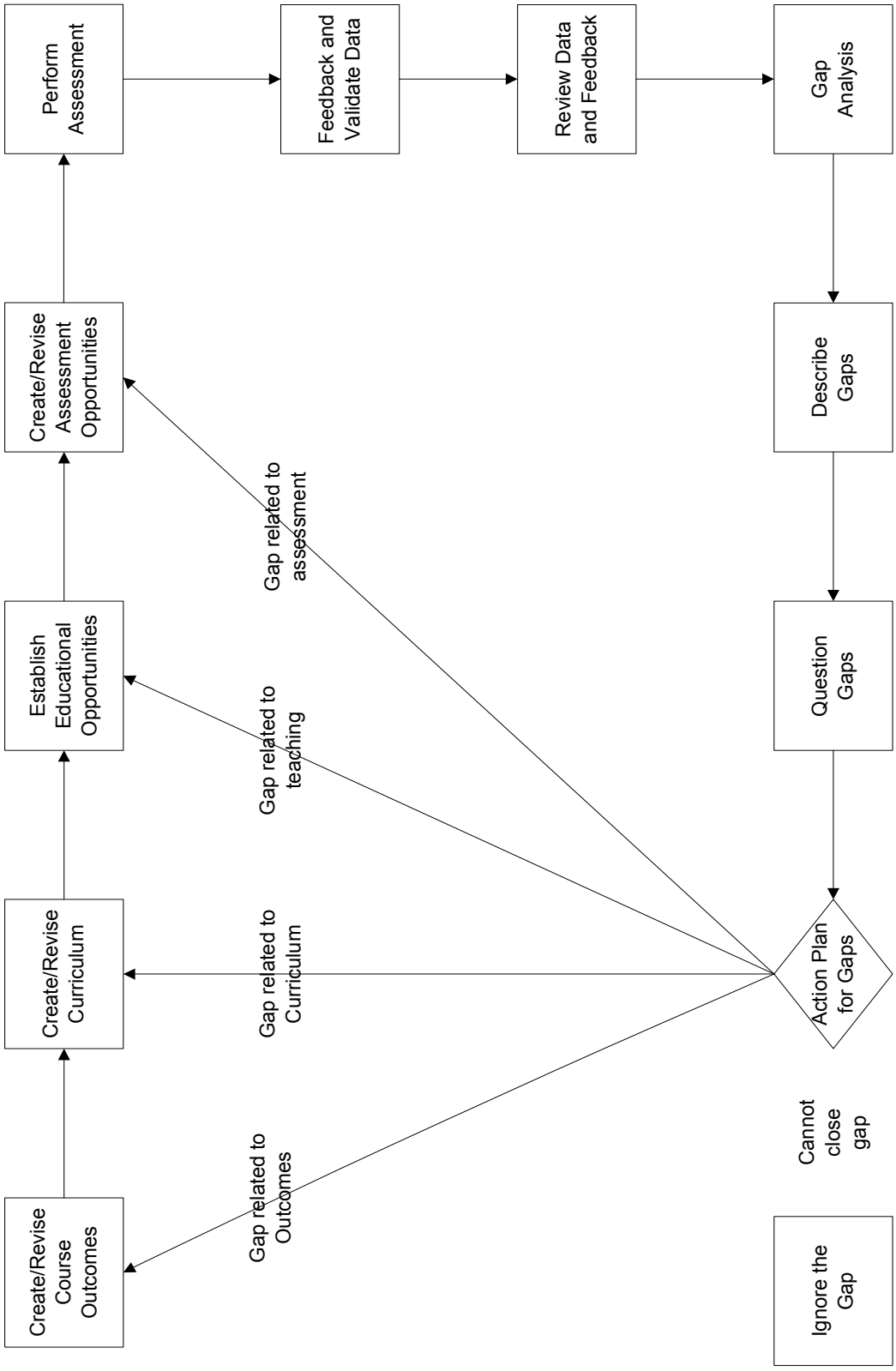

Figure 1. Evaluation and Assessment Tool

the faculty to create multidimensional assessment opportunities for students to give feedback on teaching, learning, and Metacognition (thinking about their own thinking). By creating continuous assessment activities, the faculty member can create an environment where students are continuously providing and getting feedback on their course and coursework. This should result in students feeling as though they are active participants in their own education.

The assessment tool incorporates many of the ideas of Classroom Assessment. Angelo and Cross developed Classroom Assessment Techniques, CATs, that enable faculty to get feedback on student learning, and in turn, give students feedback on whether their learning is in line with what the professor is try to teach. Classroom assessment is based on the idea that the best way to improve learning is to improve teaching. [7] Classroom Assessment is characterized as learner-centered, teacher-directed, mutually beneficial, formative, context-specific, ongoing, and firmly rooted in good practice. [8] Classroom Assessment is based on seven assumptions:

- The quality of student learning is directly, although not exclusively, related to the quality of teaching. Therefore, one of the most promising ways to improve learning is to improve teaching.
- To improve their effectiveness, teachers need first to make their goals and objectives explicit and then to get specific, comprehensible feedback on the extent to which they are achieving those goals and objectives.
- To improve their learning, students need to receive appropriate and focused feedback early and often; they also need to learn how to assess their own learning.
- The type of assessment most likely to improve teaching and learning is that conducted by faculty to answer questions they themselves have formulated in response to issues or problems in their own teaching.
- Systematic inquiry and intellectual challenge are powerful sources of motivation, growth, and renewal for college teachers, and Classroom Assessment can provide such challenge.
- Classroom Assessment does not require specialized training; it can be carried out by dedicated teachers from all disciplines.
- By collaborating with colleagues and actively involving students in Classroom Assessment efforts, faculty (and students) enhance learning and personal satisfaction.[9]

Classroom Assessment is a good fit for this tool. Classroom Assessment provides two-way communications for faculty and students to give feedback on teaching and learning.

Different CATs can be used to target different types of learning, or understanding, and attitudes. Of the fifty CATs Angelo and Cross list, about half are designed to uncover learning, and the other half to uncover student attitudes. Researchers such as Benjamin Bloom, identified three domains related to educational activity- Cognitive, Affective, and Psychomotor. The Cognitive Domain represents mental skills (knowledge), the Affective Domain represents emotions or growth in feelings (attitudes), and the Psychomotor Domain represents manual or physical skills (skills). Bloom's Taxonomy divides each domain into levels, or subdivisions, and measures abilities by observing and/or testing behaviors. Bloom's Taxonomy of the Cognitive Domain is well known and many educators use sample verbs to test students cognitive abilities. Tests imply grades, and students are motivated to do well on tests. Students will learn what they need to

know for a test, but this does not mean that students are learning or developing an understanding of the material that the faculty is attempting to teach.

Table 1combines Bloom's Taxonomy with recommended CATs. The first column lists each of the six knowledge levels. The second column is a definition of each knowledge level. The third column lists verbs that, when included in test questions and/or class discussions, would allow students to demonstrate their level of knowledge on a topic. For example, asking students to "compare and contrast using Boolean Algebra and Karnaugh Maps to simplify Product-of-Sum Logic Expressions" would give them an opportunity to demonstrate their depth of Classroom assessment techniques are usually not graded, or used for grading or evaluating students. Classroom Assessment Techniques are typically anonymous feedback for faculty to understand "what, how much, and how well students are learning". [10] The nature of CATs allows students to give feedback without the pressure of grades. Students may not expect that an assessment exercise is about to occur, but usually relax when they understand that the exercise is not graded and/or anonymous. CATs are designed to measure student behaviors in both the Cognitive and Affective Domains.

Angelo and Cross have created many useful assessment techniques for use in the classroom environment. There are additional assessment techniques that have easily been adapted to provide feedback in the classroom environment. Just as techniques were created to empower continuous improvement in the classroom, via CATs, other feedback tools were created via Continuous Quality Improvement (CQI). CQI feedback techniques were designed to give users feedback about their customers' perceptions of products and/or services. CQI techniques have been adapted and introduced into the classroom environment. It should be noted that both CQI techniques and CATs yield feedback for the person administering, as well as the person responding to, the feedback mechanism. The responder has to become aware of her response(s) to the produce or service being delivered and, in some cases, evaluate her behavior.

Faculty should perform assessment. Assessment activities should occur throughout the academic year. By including tests, quizzes, assignments, and projects, students would know when those major activities would occur (via the syllabus). Most of the assessment activities would occur during lectures, labs, and learning community activities (outside of the classroom/lab). The majority of the activities would be informal in nature. The included survey would be administered late in the first semester- allowing students to reflect on that semester's teaching, learning, learning environment, how well expectations (intended outcomes) were met (educational opportunities aligned with intended outcomes), how well students participate in the community (outside of the classroom), and how the community can (or should) change.

Assessment Technique	What is Measured	Level of Assessment	Bloom's Level
Background Knowledge Probe	Knowledge	Recall/ Understanding (Prior Knowledge)	Knowledge
One Minute Paper	Knowledge	Recall/ Understanding (Metacognition)	Knowledge Comprehension
Muddiest Point	Knowledge	Recall/ Understanding (Metacognition)	Knowledge Comprehension
Email Minute	Context and Teacher-specific feedback	Learner reactions to teaching (Metacognition)	Evaluation
Application Cards	Knowledge/Skill	Conditional Knowledge	Application
Student-generated Test Questions	Skill	Synthesis	Synthesis
Chain Notes	Context and Teacher-specific feedback	Learner reactions to teaching (Metacognition)	Evaluation
Two-way fast Feedback (CQI)	Learning process and environment	Learner reactions to teaching and Teacher reaction to feedback	N/A
Plus/Delta (CQI)	Learning/Learner process and environment	Metacognition	N/A
TTYP (alternate feedback technique)	Knowledge/Skill	Student works with a partner to formulate answers to in class questions	N/A

Table 1: Recommended Assessment Techniques

The surveys are tailored specifically to EELC. There are two surveys- one Coordinator Survey and one Student Survey. The student survey contains direct questions that specifically ask students to rate the learning community on how well it met its intended outcomes. Students are also asked indirect questions regarding certain intended outcomes. Questions 14 through 16 are questions related to student retention within ECPE.

Faculty will perform Gap Analysis. As part of the assessment process, the faculty, teaching both learning communities, will take surveys very similar to those of the students. These surveys are then used for Gap Analysis. Gap Analysis consists of defining the present state, the desired or 'target' state and hence the gap between them. [11] Gap Analysis is a tool most often used in Total Quality Management/Continuous Quality Improvement (TQM/CQI). Gap Analysis is an essential part of TQM/CQI in helping an organization determine how well it meets its stated objectives. How well an organization is meeting its objectives can be viewed from the perspective of the organization, and from the perspective of the organization's customer base. By allowing an organization to view itself from its customer's perspective can help an organization move closer toward meeting its objectives, in a manner consistent with its customer's needs.

TQM/CQI were traditionally used in the Manufacturing Sector, but was introduced to the Service Sector in the 1980s. In the Service Sector, TQM/CQI require a slightly different emphasis in data gathering and measurements. TQM/CQI rely on objective measures. When manufacturing a product, Quality Teams can measure whether assembled products meet design specifications, count the number of defective products per million produced, measure the amount of wasted material associated with the product fabrication, and measure the variability in the assembled product. Those involved in Quality Initiatives will also survey and interview customers. Customer experience and interaction with the product affects the customer response. For example, if one of the customers participating in the assessment is the purchaser, but not the user of the product, his experience and perceptions may be completely different from that of the user.

Florida Power and Light (FP&L) was the first Service Sector organization to win the Malcolm Baldrige National Quality Award as a service company. Education was included in the Baldrige Program in 1995, via the Education Pilot [12], and 1999 as a Baldrige Program Category.[13] CQI and Assessment improve organizations and programs by using feedback. CATs and CQI techniques are very similar as well. [14] This assessment tool takes advantage of the similarity to use GAP Analysis to further analyze survey responses.

In the assessment tool, the faculty survey response is treated as the “target” state, while the mean student response is the present state. The goal of using Gap Analysis is two-fold: to indicate the current state of the learning community versus the faculty-defined ideal (mean student response), and to provide an internal check for the faculty member on the state of the learning community (faculty response versus student response).

Faculty will gather feedback and validate the data. The assessment tool survey includes Qualitative and Quantitative questions. Many of the questions give respondents the opportunity to answer the questions on a 5-point Likert Scale and include some open-ended responses. By giving the students an opportunity to write comments (qualitative response), the faculty can gather additional information that cannot be included in quantitative questions. Holding focus

groups with the learning community students is an excellent opportunity to validate the data from the surveys. The survey data might lead to questions that can only be answered by the students. The group setting also is an opportunity for students to discuss their responses, and come to consensus. A neutral party familiar with running focus groups is appropriate- this removes some bias and offers students some anonymity.

The ability to gather information on student attitudes is an important part in evaluating these learning communities. Both learning communities are focused on the retention of ECPE students. Student retention is an important component in student persistence in a program, and therefore a key component in a student's decision to stay in a program. In addition, capturing student attitude data early in the program helps form baseline data for a student cohort.

Combining the data from assessment activities offers perspective on the students in the learning communities- their successes (and failures), their attitudes towards learning and working in a cooperative learning environment, their attitudes towards their chosen major, (and continuing in that major), and their attitudes towards the teaching in their respective learning communities. The data also gives the faculty members, teaching these two learning communities, feedback regarding their teaching, choice of educational opportunities, and strengths and weakness in the learning communities.

Feedback is also important to the students and other stakeholders. Students traditionally get no feedback from their responses. Classroom Assessment encourages giving students feedback. Feedback to the students in the learning communities would allow them to feel as if they are partners in their learning. Both learning communities also produce annual reports that are a ready feedback channel. The Learning Community Assessment Sub-Committee and the Provost Office are major audiences for the reports. Student feedback is also of interest to perspective Electrical and Computer Engineering students and their families.

Faculty will describe the gaps. With TQM and CQI, Gap Analysis is used to highlight areas of opportunity. Both the organization and customer groups take surveys indicating the organization's current state. By comparing the customer and organization responses, the organization can see how its view of its current state differs from its customer's view. Gaps between the two views are considered statistically significant if they are 1.0 or greater. Statistically significant gaps are usually the first places to start revisions in the program.

Gaps must be questioned. Once the gaps have been uncovered, there are some questions that need to be asked about the gaps. Are any of the gaps familiar or new? Are the gaps closing, widening, or the same? Can the gaps be closed?

Since assessment leads to change, with the goal of that change being improvement, it is possible that changes to outcomes, curriculum, and/or educational opportunities can affect the previously recorded learning community gaps. When a new set of gaps is uncovered, the first question that needs to be asked is "are any of these gaps the same as previous uncovered ones?" If the answer is yes, then the other primary questions should be asked regarding those gaps. If the gaps are new, then the faculty member should examine the survey responses and other data for reasons for

the gaps. Students can also be asked about the gaps. Feedback to students can also include additional clarifying questions.

If a gap, or gaps, continues year-to-year, one of the questions that should be asked, and answered, is "are these continuing gaps closing, widening, or are the same?" This question seeks to answer whether progress is being made in closing a gap, or set of gaps- this is the real purpose of using Gap Analysis. If progress is being made toward closing the gaps, then the faculty member needs to review changes that have helped in closing the gaps, and uncover additional changes that may shrink the gaps more. Every change will not result in the gaps closing.

As gaps continue year to year, the question of whether those gaps can be closed needs to be addressed. Some gaps may not be closed. As with quality improvement efforts (TQM, CQI, and ISO 9000), the learning communities might uncover gaps that exist simply because of perception, expectations, or preferences of customers (students). For example, the majority of students may expect that all students participating in the learning community should live together in the residence halls. This majority might express some dissatisfaction because some students chose to live (or had the option to live) elsewhere. This might be ideal for the learning community environment, but it is not ideal for students that choose to live elsewhere. If this sentiment gets expressed as a gap, it is unlikely that the learning community can maintain its flexibility and close it.

In general, "service quality characteristics are more difficult to define than those of physical products. This is because they include many important subjective elements." [15] With products, quality can usually be linked to poor or faulty design, defective components, poor durability, and faulty or improper manufacturing. The organization's employees and its customers may never come into direct contact each other.

Services, unlike products, usually require direct contact between the organization's employees and its customers. This direct contact means that the quality of the service is affected by the attitudes and behaviors of the employees and the customers. This means the service cannot be separated from the employee delivering the service, and the customer purchasing the service. In addition, the delivery of the service has to be timely, and the service has to be executed without fault. The customers' perceptions and expectations will ultimately determine the service quality.

Educational institutions are service organizations. Educational institutions have a unique relationship with their external customers (students). The students may not fully understand the breadth and depth of the service they are buying, or what constitutes the quality of that service. Additionally, students have diverse expectations. Another factor that students often confuse the reputation (quality) of the institution with the quality of a particular degree program. An additional factor is students' perceptions change over time. As students progress through their degree programs, they develop confidence and experience, and this impacts their perceptions of quality. Lastly, students interact with this service, greatly affecting the quality of the service they receive.

Given the above factors, it may be very hard to close some gaps. Gaps may exist simply because student perceptions and expectations of the Learning Communities, the faculty, the mentors,

their peers, or perceptions given to them by their parents, friends or other students. The tool includes, in the survey, places for students to write in their comments. Focus group sessions are used to verify student survey responses, and also provide opportunities to probe for the underlying causes of the gaps.

Faculty should create an action plan to make changes in the learning community. Based on the data collected, the faculty in charge of these two learning communities can determine what actions they might want to take to improve their communities. Actions may include creating or revising outcomes, curriculum, educational opportunities, and/or assessment techniques. Another possible action is to survey the students at a later date. As Sallis noted, student perceptions change as they interact and learn. [16] Administering the survey near the end of the first semester provides good feedback, but administering the survey a second time- preferably in mid-April, would allow the faculty to compare data before initiating changes. The students are asked questions on the survey that can only be answered after the start of the second semester. An alternative solution is to use two versions of the survey- one that asks about activities of the first semester and one that asks about all activities in both semesters.

Use of the evaluation tool generates performance indicators. Performance indicators are nothing more than measures against standards established by the learning communities' coordinators. Like the performance indicators created from completing the Malcolm Baldrige National Quality Award Program Assessment, the indicators from the evaluation tool will allow the learning community coordinators to know what the learning communities' strengths are, uncover the weaknesses, and have some ideas for how to improve those weaknesses. [17] Like Baldrige, or any other self-assessment, this tool provides a snapshot of how the learning communities are performing against standards. Unlike other non-Baldrige assessment tools, this tool incorporates the self assessment of the learning communities' coordinators- a key feature of the Baldrige tool, but unlike Baldrige, it does not include benchmarking against other like learning communities, is informal, and is nearly transparent to the learning community participants.

Performance indicators can be misinterpreted and misused. It is imperative that the learning community coordinators are aware of their audiences before producing performance indicators. [18] Different audiences will view performance indicators differently- seeking to use the indicators as answers to their questions. For example, the ECpE Department could use performance indicators as a measure for retention purposes, while a faculty member could use them as a measure of student preparedness for a future class.

It would be possible to make comparisons between classes within the same Learning Community. The Registrar's Office has the ability to track and gather data on student performance. This data could also include High School Class Rank (HSR), ACT and/or SAT scores, and other information. This would allow some benchmarking against ECPE students who did not participate in a learning community. The ability to include additional data may provide for additional comparisons and explanations in variability between participating groups in different years.

The survey was given to Electrical Engineering students in December 2002. Two groups were also identified for EELC. The number of first year students classified as Computer Engineers

has been significantly higher than the number of first year students electing Electrical Engineering as a major. During the 2002-03, there was approximately four times the number of students entering Computer Engineering than Electrical Engineering. Since all first year students enrolled in the ECPE Department are required to take EE185 and 186, or CPRE185 and 186, the scheduling of these classes is critical. Given the number of students enrolled in Electrical Engineering, some of the sections of EE185 and 186 were scheduled with a mix of EELC and non-EELC students. For the EELC Survey, the groups were identified as either EELC or non-EELC students. While the students took the same class, the students participating in the learning community had similar schedules.

The ability to define distinct groups within the EELC environment allowed for testing of some observations and hypotheses. These observations and hypotheses were posed as the following questions:

- Is there any difference in attitude toward EELC between EELC and non-EELC students?
- Is EELC meeting its educational outcomes?
- Are there gaps in EELC?

The expectation is that the survey would provide some usable data that, when combined with data gathered from other techniques, will answer the above questions.
The survey data was gathered and student responses were entered into an EXCEL file. Each survey was assigned a number, and the responses from each survey were entered using that number. Any written comments were entered into a second EXCEL Worksheet, using respondent number as an identifier. The respondent number was listed down the rows, and responses to questions were entered across columns. A column for comments was added to allow the person recording the data to add observations and notes. This column was used to note when respondents did not complete the survey, stated they were changing majors, or leaving the university.

The written comments were then grouped by question. By grouping the responses, general themes emerged from student responses. If the theme needed further probing, then the question and generalized responses were added to the list of questions for the focus groups. This allowed students to elaborate and discuss their responses in a group setting.

Focus group sessions were held during the Spring 2003 Semester as a follow-up to the surveys. These sessions gave students the opportunity to validate and comment on the general attitudes towards the learning community. These sessions also gave the researcher an opportunity to probe deeper into answering the questions regarding the performance of the learning community.

The Learning Community Coordinator Survey was given to the faculty in charge of the EELC. The survey contained a subset of the twenty questions on the student surveys. The questions are also modified to cause the faculty to reflect on teaching behaviors. Gap Analysis was then performed using the averaged student data and faculty data. Potential gaps were identified, and compared to student feedback. The gaps were then classified.

Lastly, the data was analyzed using One Sample and Independent Sample T-tests. These statistical tests were performed to provide statistically sound information on the questions above. While the research felt there was a difference in attitude, towards the EELC, between the identified student groups, there was little student data to support that belief.

The quality of the survey data is important for evaluating the Learning Communities. Leydens et al noted that, "In general, quantitative methods are designed to provide summaries of data that support generalizations about the phenomenon under study."[19] In short, quantitative data can yield averaged answers. For example, a class may rate a professor 3.5/5.0 on "Preparedness". The motivations and reasons behind that rating cannot be found in strictly quantitative data. To gain an understanding of how the students arrived at their ratings, one has to use qualitative methods.

There is a lot of quantitative data to be gathered in the form of tests, quizzes, homework, and laboratory exercises. That data can give the learning community coordinators a good idea of how the students performed on graded tasks, and possibly some idea of potential modifications that might improve learning. The true driver of evaluating the two learning communities is in understanding how students arrived at those scores. That information is only available by using qualitative methods of data gathering. Since the objective is to provide the learning communities with a method of measuring how well they met their learning outcomes, measuring student attitudes are very important.

Yao et al note that faculty use student feedback in different ways. Using the Student Rating of Instruction (SRI) feedback from 636 faculty at multiple universities, Yao determined that faculty used the feedback most often in creating atmosphere, motivating students, presenting engagingly, providing challenge, setting course pace, and setting course objectives. [20]

- Is there any difference in attitude toward EELC between EELC and non-EELC students?

Since all Electrical Engineering students participated in EE185/186 and there is no residential component to the EELC, the major difference between students is whether they elected to join the learning community. Students that did join the learning community were assigned reserved seats in Calculus (MATH165), Chemistry (CHEM155 or 167) and Engineering (EE185 and ENGR101) courses. Using Question 1 as a treatment, the Null and Alternative Hypotheses are shown below:

H_o: $\mu_0 = \mu_1$, There is no difference in attitudes for EELC and non-EELC EE students in EE185.

H_A: $\mu_0 <> \mu_1$, There is a difference in attitudes for EELC and non-EELC EE students in EE185.

There were no observations that implied there was a difference between students based on the participation in the learning community. This question seemed to be a place to start looking into

the departmental impacts of the learning community. Since there was only one non-EELC student responding to the survey, there are no conclusions that can be drawn for this question.

To compile the above results, multiple t-Tests were performed. For the entire family of t-Tests, an alpha of 5% ($\alpha = 0.05$) was considered acceptable. This meant a probability of a Type I error (rejecting a Null Hypothesis which in fact is true) was 5%. If there was only a single t-Test (comparison) performed, then the probability was 5%, but given there were multiple tests (comparisons) performed, alpha is really computed to be:

$\alpha_f = 1 - (1 - \alpha)^n$, where n represents the number of comparisons, α represents the significance level of each comparison, and α_f represents the significance level for the entire family. [21]

According to Larpkiataworn et al, the above formula represents the classical Bonferroni Procedure for multiple comparisons. [22] This is a statistically accepted method for multiple comparisons of data using either parametric or non-parametric statistics.

- Are there gaps in EELC?

The treatment method applied to the CELTs data was also applied to the EELC data. Gap Analysis was used to compare the student and faculty coordinator responses. A gap is identified as a difference of one or greater. Differences close to one should also be examined. If parametric statistical methods were to be used to test the data (such as t-Tests), then the following Null and Alternative Hypotheses would be appropriate:

H_o: $\mu_0 = \mu_1$, There is no difference in the mean student ratings and instructor ratings for EE185.

H_A: $\mu_0 <> \mu_1$, There is a difference in the mean student ratings and instructor ratings for EE185

Question	Mean Student Response	Coordinator Response	Difference
2	3.38	4	-0.62
3	3.53	4	-0.47
6	3.71	4	-0.29
8	**3.76**	**5**	**-1.24**
9	3.71	4	-0.29
10	3.59	4	-0.41
11	4.35	4	0.35
12	3.88	4	-0.12
13	2.94	3	-0.06

Table 2: Gap Analysis using 2002 EELC Data

Question 8 asks students to rate their opportunities to "Learn about basic Mathematical principles necessary for Electrical Engineering (Matrices, Linear Interpolation, etc)". The faculty coordinator commented "This is perhaps one of the strengths but it is Math in context". The students rated their opportunities lower. This may be an example of either a perceptual gap, or simply students misunderstanding the question. If the students misunderstood the question, then rephrasing the question is appropriate. The responses during the focus group indicated that the students were not expecting, or did not understand that, the mathematics to be in an Engineering context.

- Is EELC meeting its educational outcomes?

EELC has met its educational outcomes. Students clearly enjoyed the first semester in the learning community, and were very excited about participating in EE186. The students were interested in having all EELC students participate in all activities. They were divided on how to get everyone involved, but thought it was important that everyone be involved. Some students believed that the Living/Learning Option was a good approach, while others believed that a housing option would take away their ability to make their own housing decisions.

The student perceptions about how mathematics and C programming were presented were the biggest areas for improvement. The students were not comfortable with being asked to work on ill-defined problems. While many of them appreciated what they were being taught, they were not comfortable with the method.

There are a few areas of improvement for the evaluation tool. The first area is in wording of the questions. A few students either did not understand what was being asked, or did not read the questions carefully. Questions 4 and 5, on each of the student learning community survey, should be carefully examined to determine if there is a better way of wording them. Someone, with expertise on surveys, should read the surveys for clarity. The majority of students answered the questions in a manner that suggested they understood the questions, but there may be a way of rewording the questions to elicit more in depth responses.

The surveys should be modified for Fall and Spring semester administration. The survey for the fall semester should not include Question 13- Opportunity to practice presentation skills, as neither learning community gives the students the opportunity to present during that semester. The survey for the spring semester should have Question 13. Questions 4 and 5 may also not be appropriate for the spring semester. These questions might be replaced with follow up questions regarding the transition to college life.

Someone familiar with facilitating focus groups should conduct the focus group sessions. This would eliminate some potential bias from the sessions. In addition, the students may be more comfortable answering questions and participating in the discussions with someone they perceive as having no agenda in hearing certain answers. In addition, the focus groups should be held earlier. The ideal time would be at the end of the fall semester, and two weeks prior to the end of the spring semester. Hosting the sessions earlier would allow for data to be compiled, and feedback to the students to happen at the beginning and

end of the spring semester. Decisions regarding changes can be communicated to students in a reasonable timeframe, and the students would feel as if their feedback counted.

The surveys should also be administered earlier in the semester. Mid-semester might be an ideal time for the surveys. This may require some additional modifications to the surveys. By administering the surveys at mid-semester, the faculty coordinator will have time to analyze the results, hold focus group sessions, and report back to students on changes.

The fall semester survey could yield interesting discussions that change planning for the spring semester. That same data might be used to introduce students to topics and activities in the spring semester. Survey results from the spring could be used to talk with students about changes they would like to see in the learning communities. In this case, the students are asked to reflect on the entire learning community experience and decide on changes.

The survey results, combined with other data gathered will enable the learning community coordinator to make more informed decisions regarding curricular changes in the learning community. EELC has the resources available to continue using the tool outlined.

The tool would have to be modified for use in non-learning community settings. The tool was designed for sequential courses with closely coordinated topics and links. The tool can be modified to measure how well learning objectives, in prerequisite courses were achieved. With further modification, the tool could be used to provide additional information on how well departmental objectives were supported by departmental courses.

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