A Unified and Quantitative Approach to Assessment

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I. Introduction

A description is given of the assessment system that is being implemented at the School of Engineering at Stevens Institute of Technology for outcomes based assessment. The system meets Criteria 2, 3, and 8 of ABET (see Appendix I). The discussion is centered on the unified nature of the system, the quantitative features arising out of outcomes based grading, called *distributed grading*, and the use of web-based technology.

Our approach is unified throughout the full engineering curriculum. The goals of the engineering curriculum are grouped under three major categories: I. Broad Based Technical Expertise, II. Professional Advancement and Communications, III. World View and Personal Development. The individual goals are methodically linked to classroom and educational activities though well-defined steps that result in the expression of Program Objectives and Outcomes, as well as detailed course objectives in all courses, in all programs, under a single assessment umbrella. Course objectives are thereby explicitly linked to the educational mission of the school.

This linkage is used to assess outcomes totally within the context of the goals of the engineering school and the embedded Program Objectives. Student performance in a course is unfolded across assessment methods as in current practice but at the same time is distributed across Program Outcomes in a similar quantitative fashion. The grade distribution at the course level is projected to the program and engineering curriculum levels and thereby tied to Program Outcomes and curricular goals in a quantitative way. This permits feedback processes to have targeted information and curricular studies to be aware of curricular emphasis on individual stated outcomes, objectives and goals. Software was developed locally to facilitate this *distributed grading* procedure, including transmission of results over the web.

Student and faculty perceptions concerning the degree of difficulty, the quality of learning, the contribution to professional development, and the priorities for improvement relative to each program outcome at the course level are being measured. The objective is to synchronize faculty and student perceptions towards learning as well as to promote self-assessment. Web based commercial software is used to conduct these surveys.

Feedback is achieved by an interactive system consisting of three loops at the Course, Program and Engineering Curriculum levels. The functional elements of the feedback system are the Faculty, the Program Curriculum Committees, the Engineering Education and Assessment

Proceedings of the 2001 American Society for Engineering Education Annual Conference and Exposition

Committee, and the School of Engineering Assessment Center. The current status of our efforts is available at http://attila.stevens-tech.edu/assess/homepage.htm.

II. Educational Goals

The Stevens' curriculum has traditionally been based on a broad core that provides breadth in the sciences, engineering and the humanities while at the same time allowing for specialization in the various engineering disciplines. We have therefore taken the approach that our educational objectives can be expressed at the Engineering Curriculum Level to emphasize our unified approach to engineering education and to satisfy Criterion 3. The individual program objectives at the Program Level, required in Criteria 2 and 8, can then be expressed as matters of emphasis and application within this general structure. The implied learning objectives are finally expressed at the Course Level.

An interdepartmental committee developed a comprehensive set of educational goals over two academic years. The committee considered the outcomes stated by ABET in Criterion 3, published studies from the engineering community[1] and Stevens' Strategic Plan. The committee followed very closely a well-known model for the development of an outcomes-based assessment plan[2.] The following definitions were extracted from that model and constant attention was paid to terminology:

> **Goal:** A statement describing the broad outcome desired. A goal is far reaching and describes the best possible situation.
> **Objective:** Statement(s) derived from the goal that define the circumstances by which it will be known if the desired change has occurred.
> **Curriculum Performance Criterion:** Specific statement identifying the performance required to meet the objective. The performance must be confirmable through evidence.

Our Goals are categorized in three major divisions:

I. Broad Based Technical Expertise,
II. Professional Advancement and Communications,
III. Worldview and Personal Development.

An example from each division is given in Appendix II. The set is under scrutiny as the implementation process proceeds. It has been revised twice to this juncture, once on the basis of an alumni survey and once during the initial stages of developing course objectives. The Goals comprise the set of educational objectives at the engineering curriculum level and will ultimately assure that Criterion 3 is met by all of the programs. The Goals are projected into the individual programs through the associated Objectives. It is in the programs where the circumstances arise in which the achievement of a Goal is evident, which facilitates the projection.

Therefore, the Objectives serve as Program Objectives as required by Criteria 2 and 8. Their statement at the Program Level by the programs is essentially a restatement in terms expressive of the specialization. The Curriculum Performance Criteria can then be identified as the Program Outcomes required by Criteria 2 and 8. Their restatement at the Program Level is also in terms indicative of the individual programs. The association of Objectives and Curriculum Performance Criteria with Program Objectives and Program Outcomes respectively assures the cohesion of the engineering curriculum required by ABET and that Criterion 8 is met for all of the programs. The set of core courses taken by all engineers is considered as a (core) program in this discussion. The current status of the Program Objectives and Outcomes may be seen at http://attila.stevens-tech.edu/soe_assess/progobjandoutcomes.htm

Not all Objectives and associated Curriculum Performance criteria need be selected by each program. If preselected, they may be used to guide curriculum and course development from a top down approach. They may be initially formulated in a bottom up approach using the actual practice in the courses. The feedback part of the assessment system then assures curriculum improvement. The bottom up approach has been followed in most cases at Stevens but is being augmented by a top down approach resulting from a recent curriculum renovation..

In both approaches, the Curriculum Performance Criteria serve as categories for the more detailed and directly assessable course versions:

> **Assessment Performance Criterion:** Course-specific statement identifying the performance necessary to meet the requirements of a course. The criterion is a course-specific application of a Curriculum Performance Criterion.

The Assessment Performance Criteria constitute the learning objectives for the individual courses in the program and are grouped under the Curriculum Performance Criteria by the faculty who has responsibility for each course. The collection of Curriculum Performance Criteria across the courses constitutes the Program Outcomes from a bottom up approach. An example from Chemical Engineering, Process Analysis[3], is given in Appendix III. Other examples are available at http://attila.stevens-tech.edu/soe_assess/cpcstatus.htm. The program curriculum is fully exposed for evaluation and improvement and, through the distributed grading procedure described below, has a useful quantitative feature. The distributed grading procedure produces a mapping of the curriculum across the curriculum Goals and the program Objectives and 0utcomes. The role of a course in the educational mission of the engineering school can be fully appreciated from this point of view.

III. Direct Assessment of Learning

We were committed at the outset to assessing learning on the basis of educational outcomes in a quantitative way with at least the credibility of our current methods. We focused on fully exploiting the current grading techniques and on extending our approach to include both faculty and student attitudes towards learning.

A. Distributed grading

Upon reviewing current practice, it became obvious that we of course assess on the basis of outcomes. However, we do not report it. The outcomes based information is averaged across assessment methods and is reported as examination grades, project grades, quiz grades, and the like. Distributed grading is a procedure for exposing the outcomes based information contained in our current assessment procedures. Consider the following example.

The grades for a single student for one complete course are illustrated in Figure 1. The usual assessment methods are represented in the first column with the weighting factors that are normally assigned by the instructor in the course. The Curriculum Performance Criteria have been used as categories for the Assessment Performance Criteria (see Appendix III) and are summarized in the adjacent columns. The assessment methods are subdivided into elements (questions in an exam) as usual *except* that each element is targeted to one or more Assessment Performance Criteria within a single Curriculum Performance Criteria category only. This targeted step is the key that explicitly links the course and classroom assessment activities to the curricular objectives at all levels in a quantitative way.

Each component of the assessment method carries its own weight, the total being the weight assigned to the method. The grades received by the student are entered on a common scale. There is one occupied (grade) cell per row by this method and the cell contains a weight and a grade. It follows that sum of the weighting factors in a single column gives the weight assigned to that individual Curriculum Performance Criteria for the course. The distribution of course weights for all of the Curriculum Performance Criteria is then displayed across the row, Sum(w). Sums of the weighted grades in the columns give the grades received by the individual student for each of the Curriculum Performance Criteria, or Program Outcomes, addressed in the course. The distribution is across the row, Sum(wS).

Row sums of the weighting factors over the components of an assessment method reproduce the weight assigned to the method. Weighted row sums give the usual grade distribution over the individual assessment methods. The weighted sum over all grades gives the traditional course grade as does weighted sums over the grades for the individual Curriculum Performance Criteria or over the individual assessment methods. The weighting factor and the student's grade for each Curriculum Performance Criterion are the reportable statistics for the course.

The distributed grading procedure was adopted in a number of courses using Excel worksheets as a tool[4]. The experience was encouraging and a specific software package called SeaApp was developed locally[5] (http://attila.stevens-tech.edu/soe_assess/cpcstatus.htm) that greatly facilitates the distributed grading process. Implementation of distributed grading and use of SeaApp is voluntary until the present time. Formal integration is planned for the 2001-2 academic year that will require acceptance by the faculty and active academic leadership. The construction of the associated grading database will be progressive beginning with an average grade and weighting factor per course rather than on a student basis. Complete implementation will produce a database approximately an order of magnitude larger than our traditional one.

The weighting factors alone, even approximate ones, provide insight into the curricular emphasis given to each outcome and with the associated grades allow the assessment process to follow, for example, the learning of each student in each outcome throughout the curriculum. From a Program point of view, consider that courses in the program may be listed in the first column of Figure 1 with weighting factors determined by their credit hour contribution to the total for the program. Virtually all of the Curriculum Performance Criteria for the program appear as columns in this illustration. An entry for a student consists of a course grade for the Curriculum Performance Criterion in question and the product of the weight assigned in that course for the Curriculum Performance Criterion and the curricular course weight. It follows that column sums of the weights (product) give the quantitative weights for each Curriculum Performance Criterion in the Program curriculum. Weighted column sums of the grades give the aggregate curricular grade for each Curriculum Performance Criterion. Weighted row sums give the traditional course grades and reproduce the curricular course weights. Not only Program Outcomes can be scrutinized for individual and groups of students in this way, but the quantitative distribution of Program Objectives also can be revealed.

The approach taken to analyzing the data at the program level can be extended to the entire curriculum by considering all courses. The weighted sum over all cells gives the traditional Grade Point Average as does weighted sums over the grades for the individual Curriculum Performance Criteria or over the individual courses. In this way, the curricular emphasis given to each Objective and Goal can be delineated for all engineering students or for subgroups such as individual programs. The progressive performance of students in meeting the Goals of the engineering curriculum can thereby be studied as well as the quantitative distribution of curricular emphasis that is given to each of the Goals.

B. Attitudinal data

We have established the mechanisms required for measuring and reconciling perceptions of both students and faculty with respect to the learning process. Four major areas of concern with respect to each Curriculum Performance Criterion or Program Outcome have arisen:

- Degree of difficulty
- Quality of learning
- Contribution to professional development
- Priorities for improvement

We have selected a networked survey tool (D*cide) whereby students in selected courses are asked to respond qualitatively to questions related to the preceding topics. An illustration from D*cide is presented in Figure 2 for professional development where four outcomes are illustrated and five levels of response are possible. Analysis of the survey results can be accomplished in a number of ways. A collective assessment report is illustrated in Figure 3 wherein the responses were weighted, summed, and the distribution of total scores reported. In addition, the instructor in the course can also answer the same or similar questions and rate the class as a whole. A gap analysis between the responses of the instructor with the students responses may lead to significant improvements in learning.

We have carried out a number of surveys to gain experience and are preparing surveys to be taken at the end of the current semester in several courses in each program and in the core. We expect full implementation in the Fall 2001 semester. We are concerned with being able to reach results that can be used to improve learning, about student response rates, realistic limits on the number of surveys, etc..

IV. The Assessment Database

Our assessment database currently contains the following major items:

- Goals for the School of Engineering
- Program Objectives and Outcomes
- Individual course outcomes with weighting factors(in progress)
- Curricular maps based on weighted course outcomes
- Historical grade data for a number of programs
- Distributed grades for several courses
- Alumni survey concerning the Goals, Objectives, and Curriculum Performance Criteria
- Attitudinal surveys in several courses

The database is expanding and will eventually be augmented with term papers, summaries of design projects, the collection commonly referred to as a Student Portfolio[6,7], etc.

A. Management

Inputs to the database are facilitated by Stevens Engineering Assessment Center (**SEAC:** http://attila.stevens-tech.edu/soe_assess/seacdescript.htm) and incorporated into the decision making process. In addition, **SEAC**

- participates in the Education and Assessment Committee
- provides an official contact point on assessment for faculty, students, and administrators
- manages the assessment website
- manages the SOE assessment database
- manages the assessment server and software
- supports faculty assessment activities
- assists in the design and implementation of surveys
- supports and executes data analyses
- interacts with outside agencies and foundations
- share information and coordinate activities with School of Technology Management and the School of Applied Science and Liberal Arts

B. Software

There are two major software packages mentioned above that are directly involved in the assessment process. **SeaAPP** was developed at Stevens to facilitate the distributed grading process. It is available to all faculty and can be downloaded from the assessment website. It runs under Windows and is supported by **SEAC**. **SeaAPP** includes the following features:

- Facilitates the selection of the performance criteria (CPC) addressed by the course

- Automatically relates the assessment methods to the course objectives
- Creates a Microsoft **EXCEL™** workbook for entering and maintaining assessment results
- Creates a report on the curriculum objectives and the student performance listed by performance criteria

The software currently be used for web based student surveys and database management is **D*cide™ ABC**. The tool is available commercially (http://smartchoice.com/) and includes the following features:

- Automates questionnaire creation, distribution and data collection
- Instantaneously generates drill-down graphical and tabular reports
- Creates a personal folder organizer that protects the privacy of participants

V. The Assessment Process: Analysis and Feedback

The committees, which comprise our assessment structure, are in place and are actively engaged in establishing the interactive feedback structure that is illustrated in Figure 4. The committees are the Engineering Education and Assessment Committee and the Program Curriculum Committees, whose activities are supported by **SEAC**. The committees are free to develop the most effective means of monitoring and improving our curricula based on the educational mission of the school. The assessment database is significant and growing and offers the most relevant assessment data at the present time. The three loops at the Engineering Curriculum, Program, and Course Levels, show how assessment information is processed throughout the system.. Such processes meet Criterion 2 and Criterion 3.

At the Course Level, loop CL in Figure 4, program faculty are concerned that students are meeting the Assessment Performance Criteria for their courses and with instituting course changes that will remove measured deficiencies. The faculty is, of course, also actively engaged in establishing the learning objectives in the program. Once an interactive process at the Program Level has determined the Assessment Performance Criteria for a course, they are implemented as indicated in Figure 4.

At the Program Level, loop PL in Figure 4, the Program Curriculum Committees are concerned with the definition and subsequent monitoring of the Assessment Performance Criteria for the courses in the individual programs and for setting achievement standards or metrics consistent with those set for the engineering school. The standards are quantitative levels required for each Program Outcome. The data from distributed grading will be very relevant to this process. Overall course grades are the same so that new approaches can be compared with historical criteria.

These objectives must be continually scrutinized by communication with the major constituencies of the program. Industrial Advisory Boards have been a major resource .We are looking forward to surveys of industry and government and alumni conducted by **SEAC**. Evaluation of the results may require a specific redistribution of emphasis in the Program

Objectives by program or course modification at the Course Level. The monitoring process described above can then subsequently determine the effect of such modifications on performance. The translation of distributed grading results to the Program level will be an important ingredient.

At the Engineering Curriculum Level, loop EL in Figure 4, the Engineering Education and Assessment Committee takes responsibility for modifications and the integrity of the Goals, Objectives and Performance Criteria for the school. The school-wide committee can ascertain in a quantitative way the curricular emphasis given by the engineering curriculum to each Goal and Objective through the results of distributed grading. A unified curricular view can be adopted as well as interprogram or other course aggregates. In a unified way, the processes in loop EL assure that the outcomes expressed in Criterion 3 are met. The educational mission is a primary focus at the Engineering Curriculum Level.

The committee has recently been concerned with systematically reviewing proposed changes to the educational mission of the school that the programs need to solidify their outcomes within that umbrella. This is accomplished by a detailed review of the propositions by the Assessment Subcommittee with subsequent review and consideration for approval by the parent committee. The committee is also reviewing the Objectives and Outcomes for each Program and is thereby establishing interactions with the Program Curriculum Committees.

VI. In Conclusion

The Stevens model for assessment explicitly links goals, objectives, and performance criteria to activities at the course, program, and curriculum levels. It is an interlinked system that opens new opportunities for improvement by faculty, students, and administrators. The quantitative nature of the system generated by distributed grading makes it an attractive approach, which retains the measure of credibility that we attach to traditional grades and relies less on unfamiliar or suspected means.

Although we agree with the view that "assessment is less a 'mechanism' than a mindset,"[8] we believe that our system for quantitative measurement of the learning process can play a key role in enabling and promoting improvement by all members of the Stevens community. As the system evolves, students, faculty, and administrators can undertake different--but complementary--assessment activities at different times to derive benefits from producing shared data in an active learning culture.

Finally, we note that acceptance by the faculty and involved academic leadership are absolutely necessary conditions for the success of our assessment system. The most important conclusions must wait for acceptance to be fully reached and the positive impact on learning that it promises to deliver.

APPENDIX I
(Engineering Accreditation Commission, 1997)
ABET 2000 Criteria

Criterion 2. Program Educational Objectives

Each engineering program for which an institution seeks accreditation or reaccredidation must have in place

- *(a)* *detailed published educational objectives that are consistent with the mission of the institution and these criteria*
- *(b)* *a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated*
- *(c)* *a curriculum and process that assures the achievement of these objectives*
- *(d)* *a system of ongoing evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program*

Criterion 3. Program Outcomes and Assessment

Engineering programs must demonstrate that their graduates have

- *(a)* *an ability to apply knowledge of mathematics, science and engineering*
- *(b)* *an ability to design and conduct experiments, as well as to analyze and interpret data*
- *(c)* *an ability to design a system, component, or process to meet desired needs*
- *(d)* *an ability to function on multi-disciplinary teams*
- *(e)* *an ability to identify, formulate,, and solve engineering problems*
- *(f)* *an understanding of professional and ethical responsibility*
- *(g)* *an ability to communicate effectively*
- *(h)* *the broad education necessary to understand the impact of engineering solutions in a global and societal context*
- *(i)* *a recognition of the need for, and an ability to engage in life-long learning*
- *(j)* *a knowledge of contemporary issues*
- *(k)* *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

Each program must have an assessment process with documented results. Evidence must be given that the results are applied to the further development and improvement of the program. The assessment process must demonstrate that the outcomes important to the mission of the institution and the objectives of the program, including those listed above, are being measured. Evidence that may be used includes, but is not limited to the following: student portfolios, including design projects; nationally - normed subject content examinations; alumni surveys that document professional accomplishments and career development activities; employer surveys; placement data of graduates.

The institution must have and enforce policies for the acceptance of transfer students and for the validation of credit courses taken elsewhere. The institution must also have and enforce procedures to assure that all students meet all program requirements.

Criterion 8. Program Criteria

Each program must satisfy applicable Program Criteria. Program Criteria provide the specificity needed for interpretation of the basic level criteria as applicable to a given discipline. Requirements stipulated in each Program Criteria are limited to he areas of curricular topics and faculty qualifications. If a program, by virtue of its title, becomes subject to two or more sets of Program Criteria, then that program must satisfy each set of Program criteria; however, overlapping requirements need to be satisfied only once.

APPENDIX II
Examples of Goals, Objectives and Performance Criteria

I. Broad Based Technical Expertise

Goal 1: Scientific and engineering foundations
Goal 2: Experimentation
Goal 3: Tools
Goal 4: Technical design
Goal 5: Design assessment

Goal: (**Technical design**) the technical ability to design a prescribed engineering subsystem.

Students will be able to:

Objective A: understand the functionality of the required components or units,
The student will be able to:

Criterion 1: delineate the physical and chemical principles upon which the functions of each unit are based;
Criterion 2: identify input, output and operating variables as appropriate in various units;
Criterion 3: identify technical relationships between the input, output and variables and use the relationships to predict mutual changes.
Criterion 4: visualize objects(parts/assemblies) and represent them using standard graphical methodologies.

Objective B: utilize design equations to specify units or components,

Criterion 1: Given appropriate input and desired outputs, the students will be able to specify the characteristics of the component or unit required for its construction or acquisition.
Criterion 2: Given appropriate inputs and desired outputs, the students will be able to devise a control strategy for a unit process or system.
Criterion 3: The students will be able to obtain the engineering and scientific data required in the design equations.

Objective C: utilize the design equations and heuristics for interconnected components or units.

Criterion 1: The students will be able to apply standard design procedures for units connected in parallel, in series or by feedback.

Objective D: establish the fixed and operating costs associated with the design.

II. Professional Advancement and Communications

Goal 6: Professionalism
Goal 7: Leadership
Goal 8: Teamwork
Goal 9: Communication

Goal: (**Teamwork**) the ability to function on teams.

When engaged with team members, or as a part of a small group project, the students will:

Objective E: exhibit individual accountability in relation to the quality of group work,
The students will:

Criterion 1: provide balanced and constructive criticism in defining problems and evaluating solutions;
Criterion 2: take individual responsibility for the collective outcome of a group's work.

Objective F: practice effective listening, speaking, and writing skills,
The students will:

Criterion 1: actively listen to presentations;
Criterion 2: deliver presentations appropriate to audience and task.

Objective G: promote trust and conflict resolution,
The students will:

Criterion 1: act cooperatively and honor individual commitments;
Criterion 2: analyze conflicts and suggest solutions.

Objective H: recognize and foster the positive contributions of diverse viewpoints in problem solving,
The students will:

Criterion 1: identify and understand the assumptions associated with different conceptions of problems;
Criterion 2: take the lead in suggesting, soliciting, and developing alternative definitions of and approaches to problems.

Objective I: distinguish and contribute to multidisciplinary inputs in problem solving.
The students will:

Criterion 1: identify and appreciate disciplinary problem orientations;
Criterion 2: appreciate the advantages and limitations of disciplinary approaches to problems.

III. World View and Personal Development

Goal 10: Ethics and morals
Goal 11: Diversity
Goal 12: Lifelong learning
Goal 13: Entrepreneurship

Goal 13: (Entrepreneurship) have a fundamental knowledge and an appreciation of the technology and business processes necessary to nurture new technologies from concept to commercialization.
The students will

Objective A: understand the fundamentals of a typical business plan for a new high technology business.
The student should be able to:

Criterion 1: identify and define the elements of a typical business plan for new ventures.

Objective B: understand the fundamentals of marketing and determining customer demand for high technology new ventures / businesses.
The student should be able to:

Criterion 1: identify and apply methods to determine customer demand for typical new ventures / businesses.
Criterion 2: identify typical techniques such as quality function deployment and other market research techniques used to justify high technology new ventures related to their technology

Objective C: understand the fundamentals of engineering and business economics for high technology new ventures / businesses.
The student should be able to:

Criterion 1: identify and define the economics and finance required for typical new ventures / businesses
Criterion 2: identify typical techniques such as after tax analysis, figures of merit, income, balance sheet and income statements as well as break even analysis and other techniques used to justify hi-tech ventures related to their technology
Criterion 3: understand how the capital markets are a source of funds for new ventures.

APPENDIX III

Examples of Assessment Performance Criteria grouped Under Curriculum Performance Criteria (See Technical Design Goal, Objective B. Criterion 1 in Appendix II)

Given appropriate input and desired outputs, the students will be able to specify the characteristics of the component or unit required for its construction or acquisition:

The students will be able to determine, by graphical methods where appropriate,

- optimal flows and unit configurations
- degrees of freedom
- the number of equilibrium stages
- intra-equipment temperatures, compositions and flows for
- binary and pseudo-ternary gas absorption/stripping
- binary strippers with reboilers
- binary distillation with single feed and no side streams
- ternary co-current, cross-current and counter- current liquid-liquid extraction

For nonisothermal multi-component systems with gas-liquid equilibrium distributions depending on temperature and pressure, the student will be able to

- determine flash drum compositions and flows for a fixed temperature and pressure
- relate equilibrium calculations to distillation, cooling and vaporization applications.

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Figure 1. Distributed grading at course level

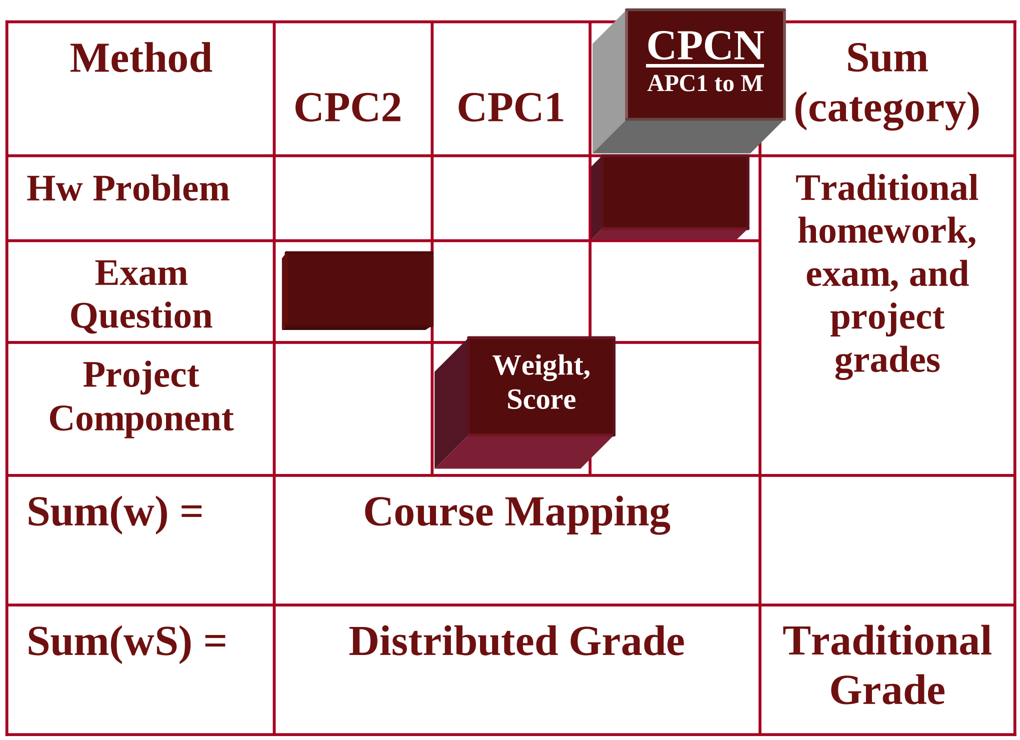
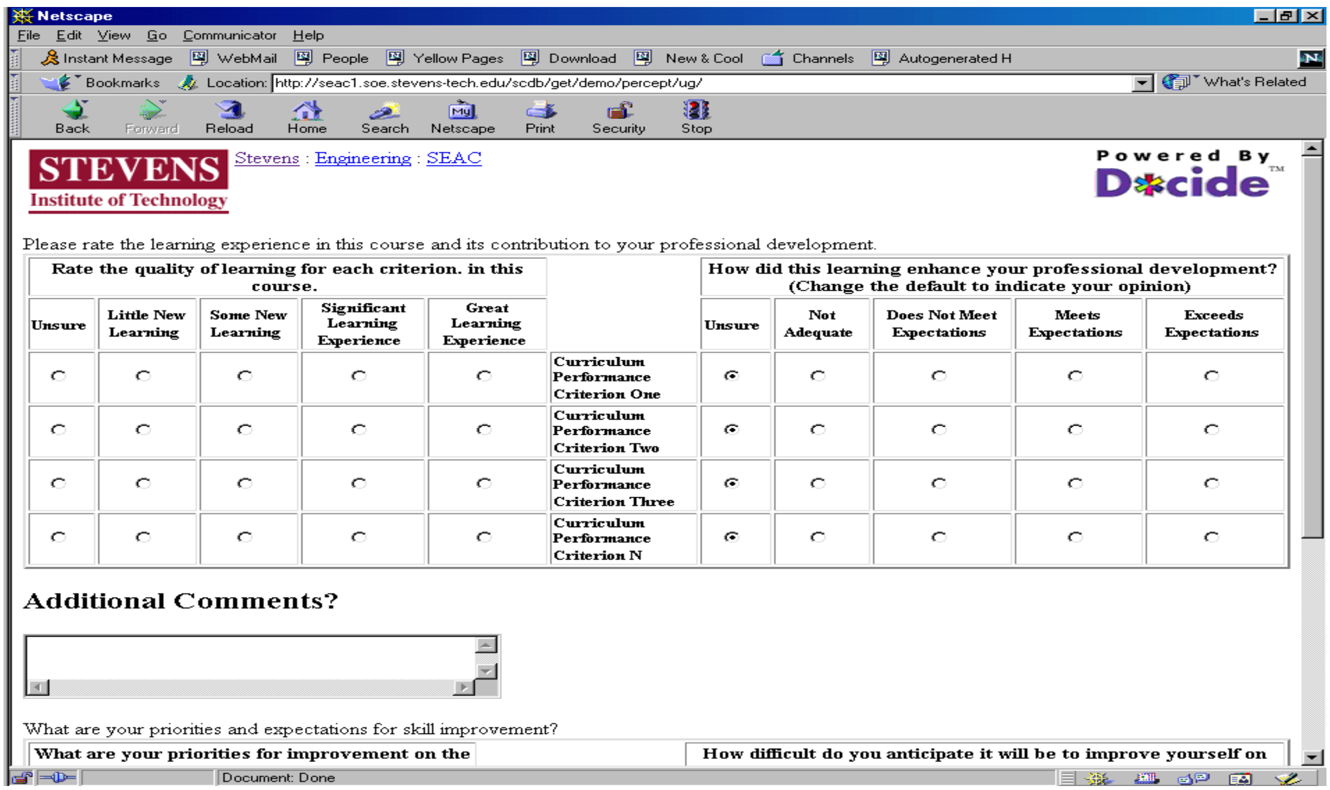


Figure 2. Attitudinal survey form - Professional Development



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Please rate the learning experience in this course and its contribution to your professional development.

Rate the quality of learning for each criterion. in this course.						How did this learning enhance your professional development? (Change the default to indicate your opinion)				
Unsure	Little New Learning	Some New Learning	Significant Learning Experience	Great Learning Experience		Unsure	Not Adequate	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
○	○	○	○	○	Curriculum Performance Criterion One	◉	○	○	○	○
○	○	○	○	○	Curriculum Performance Criterion Two	◉	○	○	○	○
○	○	○	○	○	Curriculum Performance Criterion Three	◉	○	○	○	○
○	○	○	○	○	Curriculum Performance Criterion N	◉	○	○	○	○

Additional Comments?

What are your priorities and expectations for skill improvement?

What are your priorities for improvement on the

How difficult do you anticipate it will be to improve yourself on

Figure 3. Attitudinal survey report form - Professional Development

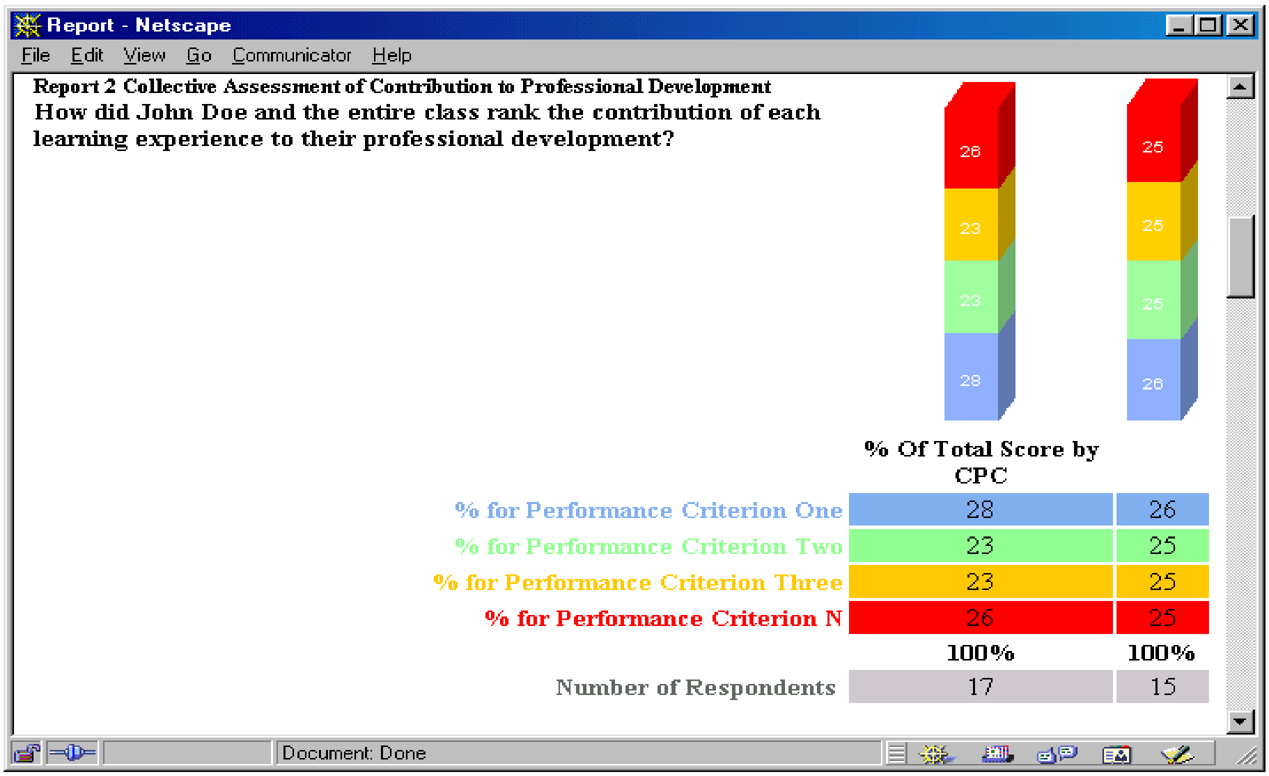

Figure 4. Stevens' Three Loops