PROGRAMME OUTCOMES ASSESSMENT

Implementation -- developing a sustainable plan

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OBE -- DOES IT WORK

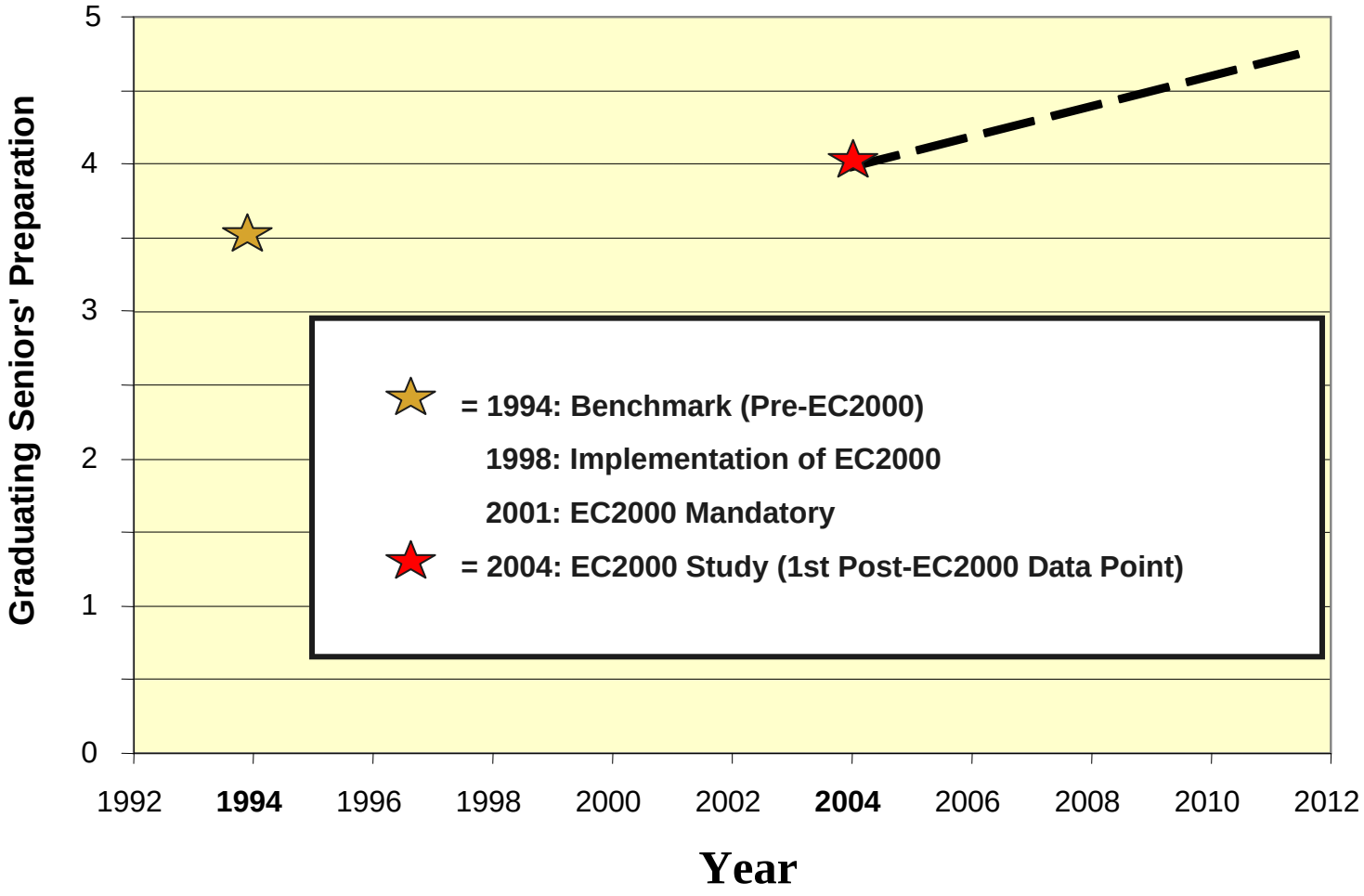
Penn State Longitudinal Study of ABET 2000
News Release

"In all nine engineering knowledge and skill areas emphasized by the new standards, the 2004 graduates in the aggregate have significantly, and often substantially, higher skill levels than did their counterparts from a decade earlier."

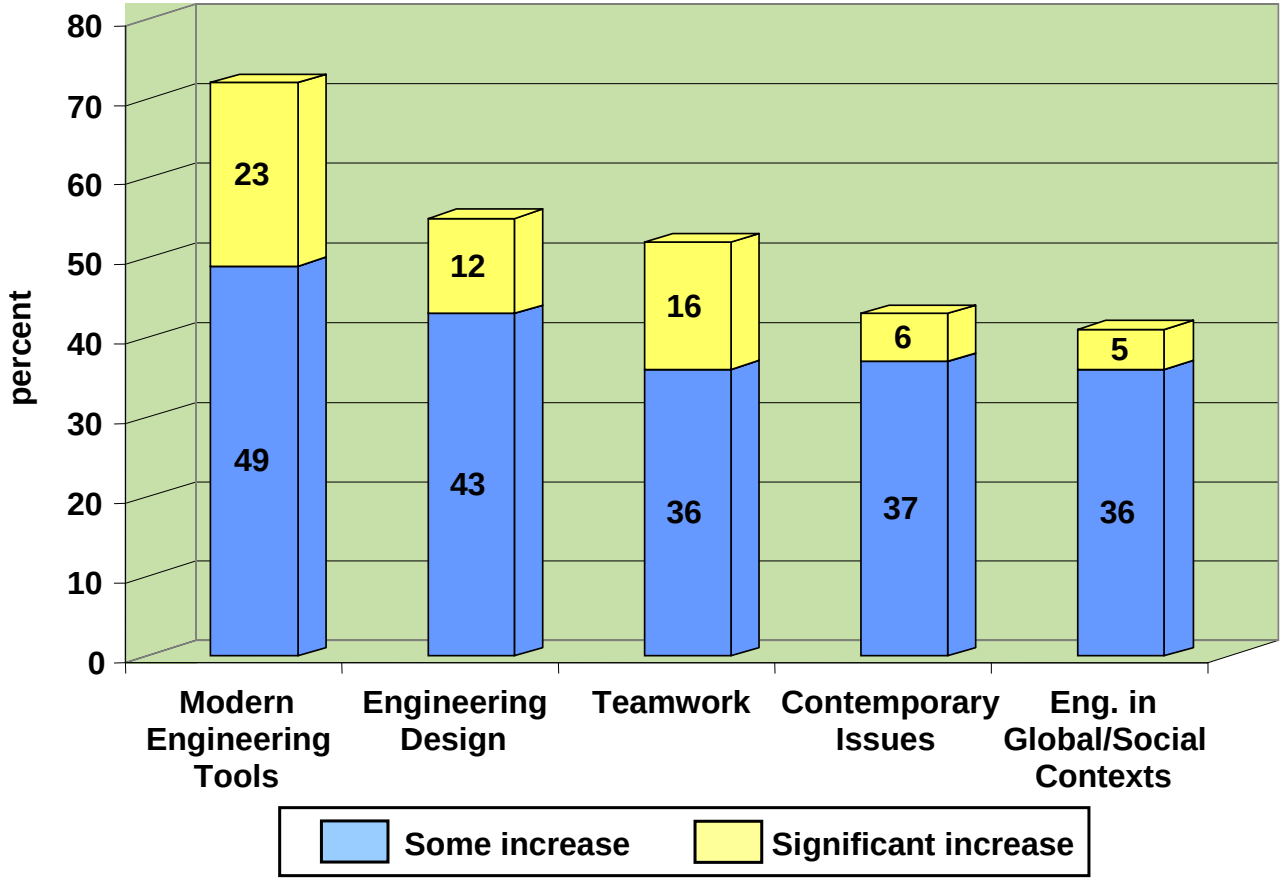
STATISTICS OF STUDY

- **NUMBER OF SCHOOLS 40**
  - Doctorate, Masters, Bachelors
- **TYPES OF SCHOOLS**
  - Research, Teaching
- **TYPES OF ENGINEERING PROGRAMMES**
  - Chemical, Civil, Electrical, Industrial, Mechanical, Aerospace, Computer
- **SCOPE OF DATA**
  - 3,000 faculty surveyed
  - 185 program chairs surveyed
  - More than 11,500 students surveyed
  - More than 13,000 engineering alumni surveyed
  - More than 1,600 employer responses

TRACKING LEARNING OUTCOMES OF EC2000

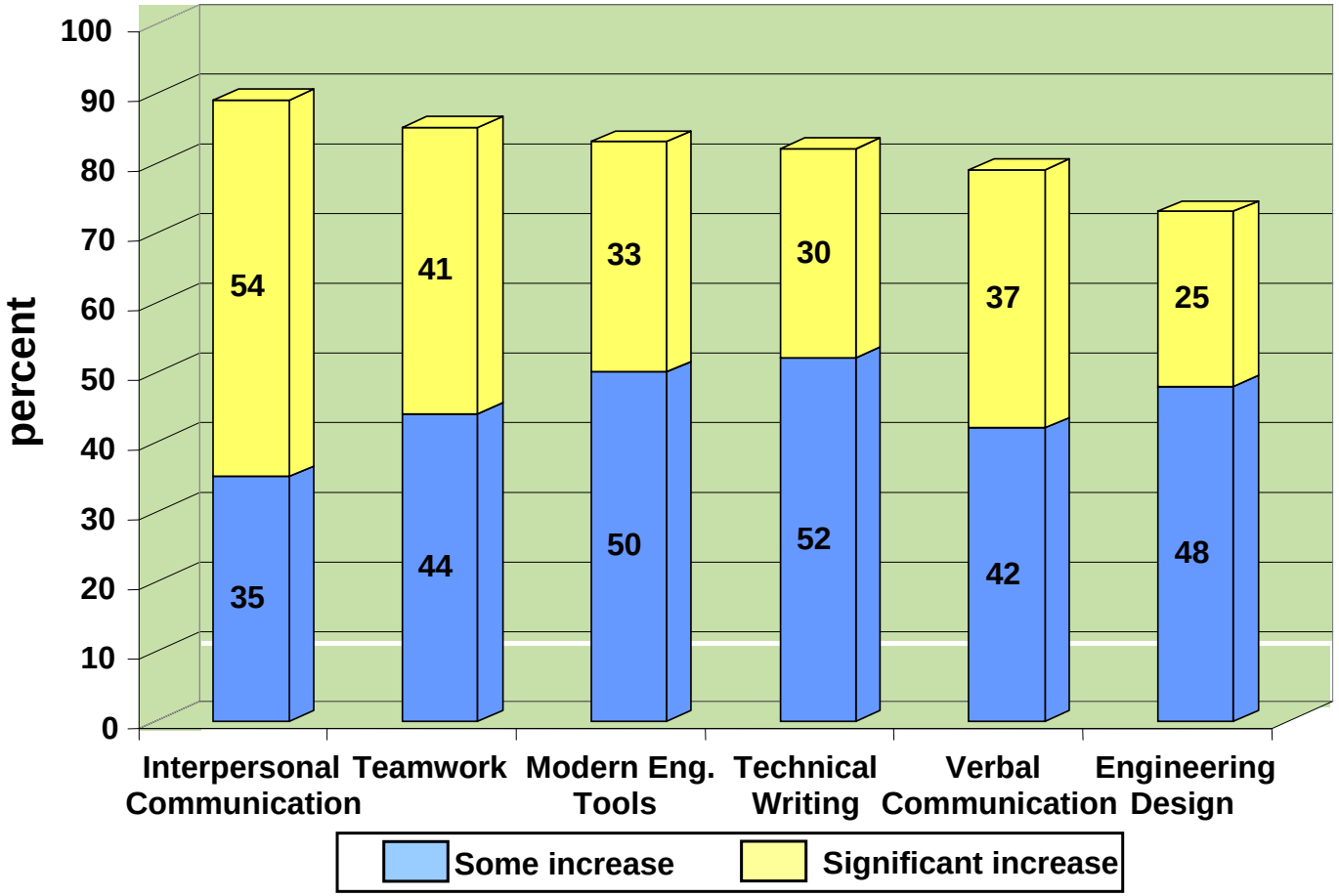


FACULTY REPORTS OF CHANGES IN CONTENT EMPHASES SINCE FIRST TEACHING THE COURSE



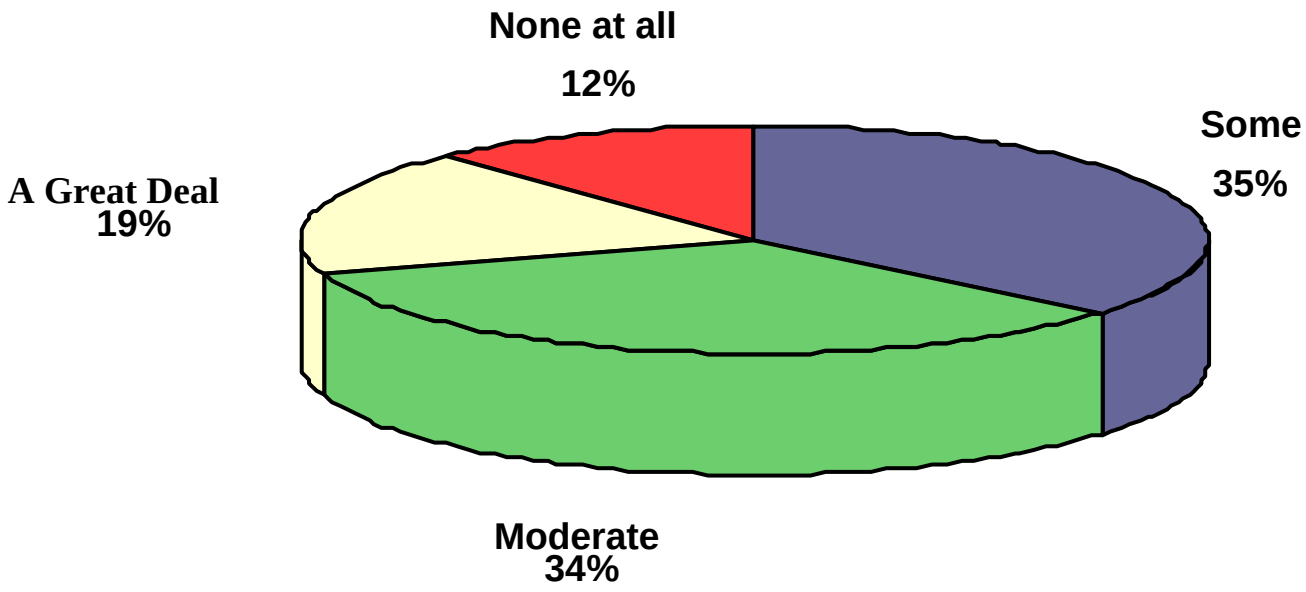
5-point scale, where 1 = “Significant Decrease” and 5 = “Significant Increase”

Program Chairs' Reports of Changes in Curricular Emphases Over the Past Decade



5-point scale, where 1 = "Significant Decrease" and 5 = "Significant Increase"

EFFORT REQUIRED VERSUS VALUE



Level of personal effort: 68% say effort is “about right”

HIERARCHY OF OUTCOMES ASSESSMENT PROCESS

VOCABULARY USED IN OUTCOMES ASSESSMENT

TERM	DEFINITION	OTHER TERMS USED
OBJECTIVES	Statements that describe the expected accomplishments of the graduates during the first few years after graduation.	Goals, outcomes, standards
OUTCOMES	Statements that describe what students are expected to know and be able to do by the time of graduation.	Objectives, standards, goals
PERFORMANCE MEASURES	Specific measurable statements identifying the performance(s) required to meet the outcome that can be confirmed through evidence.	Standards, rubrics, specifications, outcomes, metrics, objectives
RUBRICS	A set of measurable components that when satisfied will ensure meeting a higher level or broader performance measure.	Metric, outcome
ASSESSMENT	Processes that identify, collect, analyze, and report data that can be used to evaluate achievement.	Evaluation
BENCHMARKS	Expected levels of performance of student cohorts on specific performance measures.	Standards, metrics, specifications
EVALUATION	Process of reviewing the results of data collection and analysis against benchmarks and making a determination of the action(s) to be taken.	Assessment

Elements Needed for Implementation

- Determine educational objectives consistent with mission of university
- Determine outcomes needed consistent with achieving objectives
- Determine performance measures needed to evaluate outcomes
- Determine data sampling requirements and timelines for data gathering
- Determine benchmarks desired for each performance measure
- Determine feedback processes to be used to improve educational experience

Know Your Constituents

- Faculty
- Students
- Industry
- Government
- Graduate Schools
- Parents
- Other

LEARNING OUTCOMES

(Desired knowledge, skills, attitudes, behaviors at time of completing programme)

- ↓ **Outcomes are identified**
- ↓ **Number of outcomes are MANAGEABLE**
- ↓ **Outcomes are publicly documented**
- ↓ **Outcomes are linked to educational objectives**
- ↓ **Outcomes are defined by a MANAGEABLE number of performance indicators**
- ↓ **Outcomes are aligned with mission**

ASSESSMENT -- IT IS POSSIBLE TO DO TOO MUCH

- **Is the process sustainable?**
  - **If the time required, or the workload is onerous, the faculty will not stay committed to the process.**
  - **If the faculty is not committed to the process it will fail.**
- **Does the data we gather address the core outcomes?**
  - **There is no advantage to collecting data that we don't use.**
  - **Be sure that there is a well-defined rationale for the data you collect. If the data is too general how can it be used to improve?**
- **Do we need to collect data on every student for every outcome every year?**
  - **Develop a sampling plan.**
  - **Outcomes that are met don't need to be sampled as often as outcomes that are not.**
  - **Remember -- you are assessing the programme, not each individual student.**

OUTCOME ASSESSMENT -- AN OPEN ENDED DESIGN PROBLEM

- **Think of our students as our educational product.**
  - **Students are the product for those employing them or evaluating them for further study (e.g. graduate schools).**
  - **Students are also "purchasers" in the sense that they have expectations of how well they will be prepared to achieve their career goals.**
- **What are the needs of our clients -- both internal and external?**
  - **Don't forget that our faculty colleagues are also clients. They expect certain knowledge and skills when receiving students in subsequent courses.**
- **What are the expectations of quality and quantity?**
  - **How do we define quality (how good is good enough)?**
  - **How do we determine the trade-off of depth versus breadth?**

BALANCED APPROACH

- **Is it possible to be all things to all people?**
  - **No programme can do everything.**
  - **No programme can meet the needs of all clients.**
- **Programmes are constrained .**
  - **Time**
  - **Finances**
  - **Background of students**
  - **Capability of students**
  - **Expertise of faculty**
  - **Physical facilities**
- **Manage the expectations of your internal and external clients.**
  - **Set outcomes that are consistent with the programme constraints.**

EFFORT REQUIRED

How many engineers would you expect to find on a project to design an aircraft?
How many engineers would you expect to find on a project to design a nuclear power plant?
How many engineers would you expect to find on a project to design a new computer?

LOTS

WHERE IN THIS CONTINUUM DOES OUTCOMES ASSESSMENT FIT (HOW COMPLEX IS THE PROBLEM)?

How many engineers would you expect to find on a project to design a new rivet?
How many engineers would you expect to find on a project to design a new optical element?
How many engineers would you expect to find on a project to design a new transformer?

FEW

Course versus Programme Assessment

- Questions to ask
  - Are you assessing individual students or groups of students?
  - Are you assessing for formative or summative purposes?
  - Are you assessing students or programmes?
  - Are you interested in demonstrating “value added” or only attributes at the end of a programme?
  - Are you using holistic or analytical tools?

Course versus Programme Outcomes

- Programme
  - Can graduates (groups of students) demonstrate the ability to perform at an acceptable level in each of the programme outcomes?
    - Provide evidence that students (on average) can demonstrate knowledge or skills directly linked to outcomes.
- Course
  - Is the student exposed to sufficient depth and breadth in the subject matter?
  - Has the student provided evidence that they have mastered a sufficient level of understanding at the level expected for the course?

Are there course outcomes that support programme outcomes?

YES -- IN GENERAL THEY NEED TO BE RECAST

RUBRICS[1]

A rubric is a set of categories developed from the performance criteria that define and describe progression toward meeting important components of work being completed, critiqued, or assessed.

Objective: Graduates will exhibit effective communications skills.

Outcomes: By the time of graduation, students will:

- **Demonstrate effective written communication skills.**
- **Demonstrate effective oral communication skills.**

Performance criteria (indicators) for written communication skills:

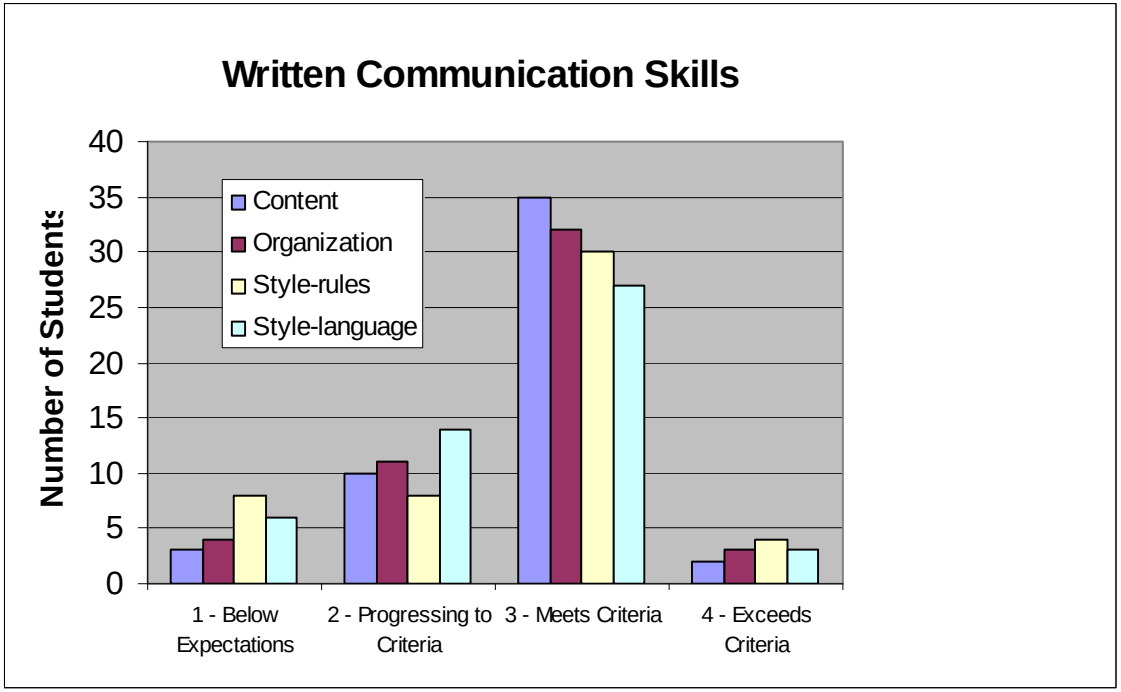
- **Organization**
- **Content**
- **Style – language**
- **Style -- rules**

RUBRICS (Cont.)

	4 – Exceeds Criteria	3 – Meets Criteria	2 – Progressing to Criteria	1 – Below Expectations
Content	Provides ample supporting detail to support solution/ argument.	Provides adequate supporting detail to support solution/ argument.	Some details but may include extraneous or loosely related material.	Inconsistent or few details that may interfere with the meaning of the text.
Organization	Organizational pattern is logical & conveys completeness & wholeness.	Organizational pattern is logical & conveys completeness & wholeness with few lapses.	Little completeness & wholeness, though organization attempted.	Little evidence of organization or any sense of wholeness & completeness.
Style	Uses effective language; makes engaging, appropriate word choices for audience & purpose.	Uses effective language & appropriate word choices for intended audience & purpose.	Limited & Predictable vocabulary, perhaps not appropriate for intended audience & purpose.	Limited or inappropriate vocabulary for the intended audience & purpose.
	Consistently follows the rules of standard English.	Generally follows the rules for standard English.	Generally does not follow the rules of standard English.	Does not follow the rules of standard English.

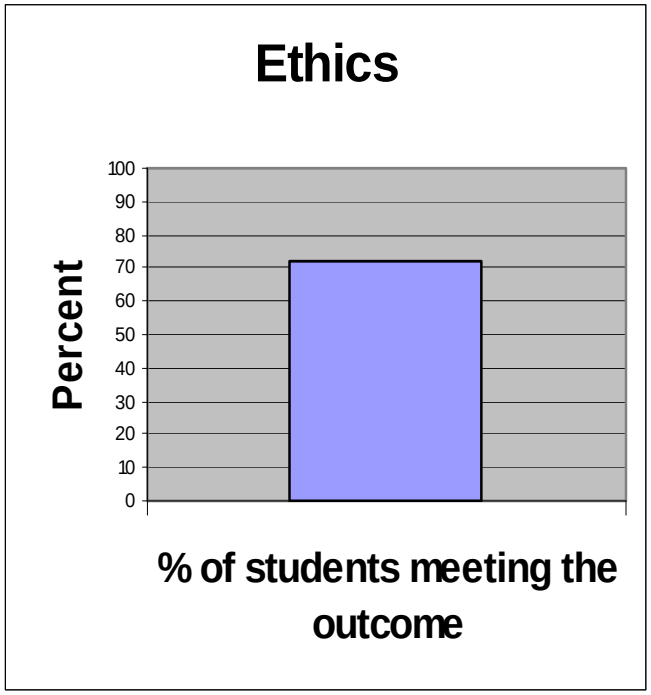
1 Taken from ABET, Community Matters, Assessment 101, Assessment Tips with Gloria Rogers, Ph.D.

RUBRICS (Cont.)

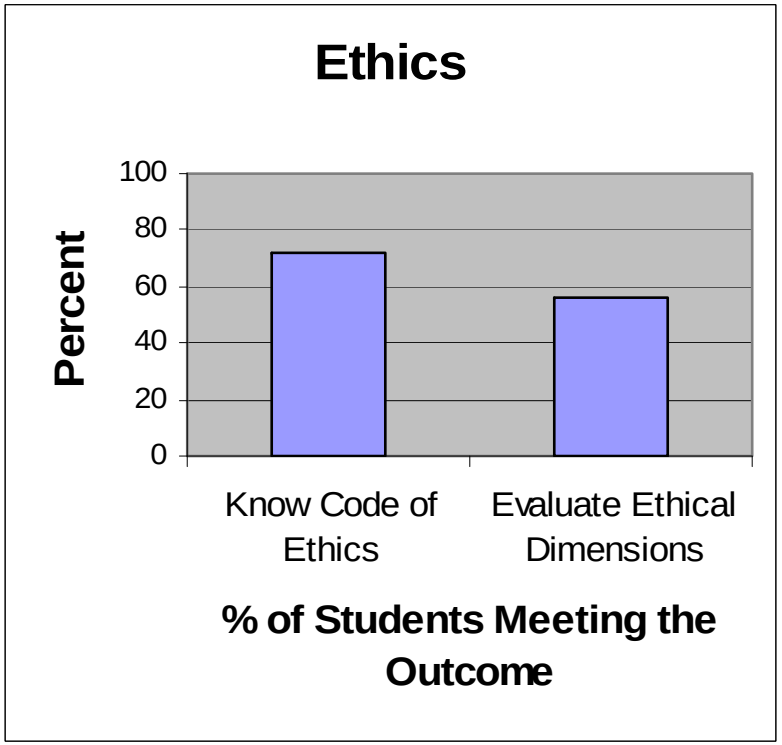


Performance Measures -- Data versus Information

By the time of graduation, students should understand ethical responsibilities



By the time of graduation, students should know the code of ethics for their discipline; and be able to evaluate the ethical dimensions of a problem in their discipline.



EXAMPLE OF SETTING OBJECTIVES

- **FACULTY DETERMINE A STRAWMAN OF OBJECTIVES**
  - **Keep number small (3-5)**
- **FACULTY MEET WITH ADVISORY COMMITTEE(S)**
  - **Modify, clarify and verify final list of OBJECTIVES**

GOOD EDUCATIONAL OBJECTIVE

- **To provide students with a broad base of knowledge in the fundamentals of chemical engineering**

BAD EDUCATIONAL OBJECTIVE

- **To educate students to be the CEOs of major chemical industry corporations**

EXAMPLE OF SETTING OUTCOMES

- **FACULTY DETERMINE A STRAWMAN OF OUTCOMES**
  - **Remember these are programme outcomes, not course outcomes**
- **FACULTY MEET WITH ADVISORY COMMITTEE(S)**
  - **Modify, clarify and verify final list of OUTCOMES**

GOOD OUTCOME

- **An ability to apply the knowledge of mathematics, science (especially chemistry), and engineering.**

BAD OUTCOME

- **An ability to solve all nonlinear differential equations for chemical processes.**

EXAMPLE OF SETTING PERFORMANCE MEASURES

- **FACULTY DETERMINE A STRAWMAN OF PERFORMANCE MEASURES**
  - **Keep number small**
- **FACULTY MEET WITH ADVISORY COMMITTEE(S)**
  - **Modify, clarify and verify final list of PERFORMANCE MEASURES**

GOOD PERFORMANCE MEASURE

- **Faculty assessment of student ability to apply appropriate mathematics to solving engineering problems (Rubric)**

BAD PERFORMANCE MEASURE

- **Grade in calculus class**

EXAMPLE OF SETTING BENCHMARKS

- **FACULTY DETERMINE A STRAWMAN OF BENCHMARKS**
  - Keep number small
- **FACULTY MEET WITH ADVISORY COMMITTEE(S)**
  - Modify, clarify and verify final list of BENCHMARKS

GOOD BENCHMARK

- 80% of students will perform successfully on a normed examination

BAD BENCHMARK

- 100% of students will be able to solve complex non-linear problems

EXAMPLE OF SETTING PROCESSES

- **FACULTY DETERMINE A STRAWMAN OF PROCESSES**
  - Keep number small
- **FACULTY MEET WITH ADVISORY COMMITTEE(S)**
  - Modify, clarify and verify final list of PROCESSES

GOOD PROCESS

- Faculty members meet regularly to study results of performance measures and benchmarks and suggest changes in programme

BAD PROCESS

- A single faculty member suggests changes in courses

SAMPLE OBE PLAN

CHEMICAL ENGINEERING PROGRAM

UNIVERSITY MISSION

- **TO SERVE THE CITIZENS OF THE STATE BY PRODUCING WELL EDUCATED CONTRIBUTORS TO SOCIETY**
- **TO PROVIDE AN EDUCATION THAT WILL PROVIDE OPPORTUNITIES FOR STUDENTS TO BE GAINFULLY EMPLOYED AND TO PROGRESS IN THEIR CHOSEN CAREERS**
- **TO PROVIDE AN EDUCATION THAT PREPARES STUDENTS IN UNDERSTANDING INTERNATIONAL AFFAIRS SO THAT THEY MAY SUCCESSFULLY PARTICIPATE IN A WORLD ECONOMY**

PROGRAMME OBJECTIVES

- **TO PROVIDE STUDENTS WITH A BROAD BASE OF KNOWLEDGE IN THE FUNDAMENTALS OF CHEMICAL ENGINEERING**
- **TO HELP STUDENTS DEVELOP A DESIRE FOR LIFE-LONG LEARNING AND PROFESSIONAL DEVELOPMENT**
- **TO PRODUCE ENGINEERS WITH THE ABILITY TO EXCEL, IN AN HONORABLE FASHION, IN INDUSTRY, GOVERNMENT OR ACADEMIA**

PROGRAMME OUTCOMES

A. AN ABILITY TO APPLY THE KNOWLEDGE OF MATHEMATICS, SCIENCE (ESPECIALLY CHEMISTRY), AND ENGINEERING

B. AN ABILITY TO DESIGN AND CONDUCT EXPERIMENTS, AS WELL AS TO ANALYZE AND INTERPRET DATA
   - TO INCORPORATE THE KNOWLEDGE GAINED FROM EXPERIMENTATION AND THE LITERATURE INTO COMPUTER MODELS, STEADY STATE AND DYNAMIC

C. AN ABILITY TO DEVELOP AND DESIGN A SYSTEM, UNIT OPERATION, OR PROCESS TO MEET DESIRED OR ANTICIPATED NEEDS, INCLUDING:
   - THE ABILITY TO COMPOSE A PROCESS FLOW DIAGRAM AND UNDERSTAND A PIPING AND INSTRUMENTATION DIAGRAM

D. THE ABILITY TO FUNCTION EFFECTIVELY IN A TEAM SETTING
   - PROGRAMME RELATED TEAMS FOR PROJECTS AND RESEARCH
   - MULTI-DISCIPLINARY TEAMS

PROGRAMME OUTCOMES (cont.)

E. THE ABILITY TO IDENTIFY, FORMULATE, AND SOLVE CHEMICAL ENGINEERING PROBLEMS IN A WIDE RANGE OF AREAS, INCLUDING:

1. ENVIRONMENTAL, HEALTH, AND SAFETY
2. BIOCHEMICAL/BIOMEDICAL
3. REFINING/CHEMICAL PROCESSING
4. POLLUTION PREVENTION AND REMEDIATION

F. AN UNDERSTANDING OF PROFESSIONAL AND ETHICAL RESPONSIBILITY

G. AN ABILITY TO COMMUNICATE EFFECTIVELY AND TO USE CURRENT COMPUTER TOOLS TO PRESENT COMPLICATED CONCEPTS IN A LUCID MANNER

H. A KNOWLEDGE OF CONTEMPORARY AND SOCIETAL ISSUES AND AN APPRECIATION OF THE IMPACT OF ENGINEERING SOLUTIONS IN A GLOBAL CONTEXT

I. A RECOGNITION OF THE NEED FOR CONTINUAL SELF-RENEWAL AND THE ABILITY TO ENGAGE IN LIFE-LONG LEARNING

PROGRAMME PERFORMANCE MEASURES AND BENCHMARKS

- SENIOR DESIGN PROJECT (OUTCOMES A, B, C, D, E, G, AND H)
  - ALL CHEMICAL ENGINEERING STUDENTS ARE CURRENTLY REQUIRED TO COMPLETE A SENIOR DESIGN ELECTIVE COURSE. THIS COURSE REQUIRES A SUBSTANTIAL DESIGN PROJECT THAT INTEGRATES KNOWLEDGE FROM MANY PARTS OF THE CHEMICAL ENGINEERING CURRICULUM AND CULMINATES IN AN ORAL PRESENTATION AND WRITTEN DESIGN REPORT. THE INSTRUCTORS OF THESE COURSES WILL EVALUATE EACH STUDENT'S ACHIEVEMENTS IN OUTCOMES A, B, C, D, E, G, AND H.
    - AT LEAST 80% OF CHE STUDENTS WILL DEMONSTRATE BASIC COMPETENCY IN OUTCOMES A, B, C, D, E, G, AND H.

PROGRAMME PERFORMANCE MEASURES AND BENCHMARKS (cont.)

- FUNDAMENTALS OF ENGINEERING EXAM (OUTCOMES A AND E)
  - ALL CHEMICAL ENGINEERING STUDENTS ARE CURRENTLY REQUIRED TO TAKE THIS NATIONAL EXAM AFTER COMPLETING 75% OF THEIR CHE COURSEWORK.
    - AT LEAST 90% OF OUR STUDENTS WILL PASS THIS EXAM ON THE FIRST TRY.

- SURVEY OF GRADUATING SENIORS (OUTCOMES A THROUGH I)
  - ALL CHE STUDENTS WILL COMPLETE A WRITTEN SURVEY IN THE FINAL SEMESTER BEFORE GRADUATION THAT DOCUMENTS THEIR PERCEPTION AS TO WHETHER OR NOT THEY HAVE ACHIEVED EACH OF THE DESIRED OUTCOMES.
    - AT LEAST 85% OF GRADUATING SENIORS WILL FEEL THAT THEY HAVE ACHIEVED ALL OF THE DESIRED OUTCOMES.

PROGRAMME PERFORMANCE MEASURES AND BENCHMARKS (cont.)

- SURVEY OF ALUMNI (OUTCOMES A THROUGH I)
  - WE WILL ATTEMPT TO CONTACT ALL ALUMNI OF THE CHE PROGRAMME 2 YEARS AFTER GRADUATION AND REQUEST THAT THEY COMPLETE A FOLLOW-ON SURVEY.
    - AT LEAST 80% OF RESPONDENTS WILL BE ACTIVELY WORKING AS CHES, OR CONTINUING WITH GRADUATE STUDIES. AT LEAST 80% WILL FEEL THEY HAVE SUFFICIENTLY ACHIEVED THE DESIRED OUTCOMES TO PREPARE THEM FOR A CAREER IN CHE.

PROGRAMME PERFORMANCE MEASURES AND BENCHMARKS (cont.)

- SURVEY OF EMPLOYERS (OUTCOMES A THOUGH I)
  - ALL ORGANIZATIONS THAT EMPLOY OUR STUDENTS AFTER GRADUATION WILL BE INVITED TO COMPLETE A SURVEY THAT DOCUMENTS THEIR PERCEPTION AS TO WHETHER OR NOT OUR STUDENTS HAVE ACHIEVED DESIRED OUTCOMES E THROUGH I. RESPONDENTS WILL BE ENCOURAGED TO MAKE SPECIFIC RECOMMENDATIONS FROM THEIR PERSPECTIVE REGARDING HOW THE CHE PROGRAMME MIGHT BE IMPROVED TO BETTER MEET THE NEEDS OF EMPLOYERS. RESPONDENTS THAT WISH TO TAKE A MORE ACTIVE ROLE IN GUIDING THE PROGRAMME WILL BE INVITED TO BECOME PART OF AN INDUSTRIAL ADVISORY BOARD TO PROVIDE INPUT TO THE CHE PROGRAMME ON A CONTINUING BASIS.
    - AT LEAST 80% OF THE RESPONDENTS WILL BE SATISFIED WITH THE PERFORMANCE OF EMPLOYEES THAT GRADUATED FROM THE CHE PROGRAMME.

PROGRAMME FEEDBACK PROCESSES

- FACULTY ASSESSMENT COMMITTEE
  A COMMITTEE OF CHE FACULTY WILL BE FORMED TO EVALUATE THE ASSESSMENT RESULTS OBTAINED ABOVE. THEY WILL COMPILE AND ANALYZE THE RESULTS EACH YEAR TO DETERMINE IF THE ASSESSMENT GOALS ARE BEING MET. IF DEFICIENCIES ARE NOTED IN EITHER THE ACHIEVEMENT OF THE DESIRED OUTCOMES, OR IN THE ASSESSMENT TOOLS, THEY WILL RECOMMEND SPECIFIC CHANGES TO THE CHE FACULTY. THE ASSESSMENT RESULTS AND ANY RECOMMENDED CHANGES WILL BE COMPLIED IN A WRITTEN REPORT. THE GOAL WILL BE THAT EACH ANNUAL ASSESSMENT WILL RESULT IN SPECIFIC CHANGES TO IMPROVE THE CHE PROGRAMME.

OUTCOME MATURITY MATRIX

Stakeholder Involvement (Those who have a vested interest in the outcome of the program)	RATING	Performance Objectives (Graduates performance 3-5 years after completing program)	RATING	Learning Outcomes (Desired knowledge, skills, attitudes, behaviors at time of completing program)	RATING	Outcomes aligned with educational practices	RATING	Program and/or Institutional Assessment	RATING	Evaluation	RATING
Stakeholders are identified		Objectives are defined		Outcomes are identified		Desired outcomes are mapped to educational practices and/or strategies		Assessment is systematic at the program/institutional level		Assessment data are systematically reviewed	
Primary stakeholders are involved in identifying educational objectives		Stakeholders provide input to development of objectives		Number of outcomes are manageable		Outcomes are mapped to both curricular and cocurricular activities		Multiple methods are used to measure each outcome		Evaluation of results are done by those who can effect change	
Primary stakeholders are involved in periodic evaluation of educational objectives		Number of objectives are manageable		Outcomes are publicly documented		Practices/strategies are systematically evaluated using assessment data		Both direct and indirect measures of student learning are used to measure outcomes		Evaluation of assessment data is linked to practices	
Sustained partnerships with stakeholders are developed		Objectives are aligned with mission		Outcomes are linked to performance objectives		Educational practices are modified based on evaluation of assessment data		Assessment processes are reviewed for effectiveness and efficiency		Evaluation leads to action	
		Objectives are periodically assessed		Outcomes are defined by a manageable number of measurable performance indicators				Assessment methods are modified based on evaluation processes			
		Objectives are periodically evaluated for relevancy		Outcomes are aligned with mission							