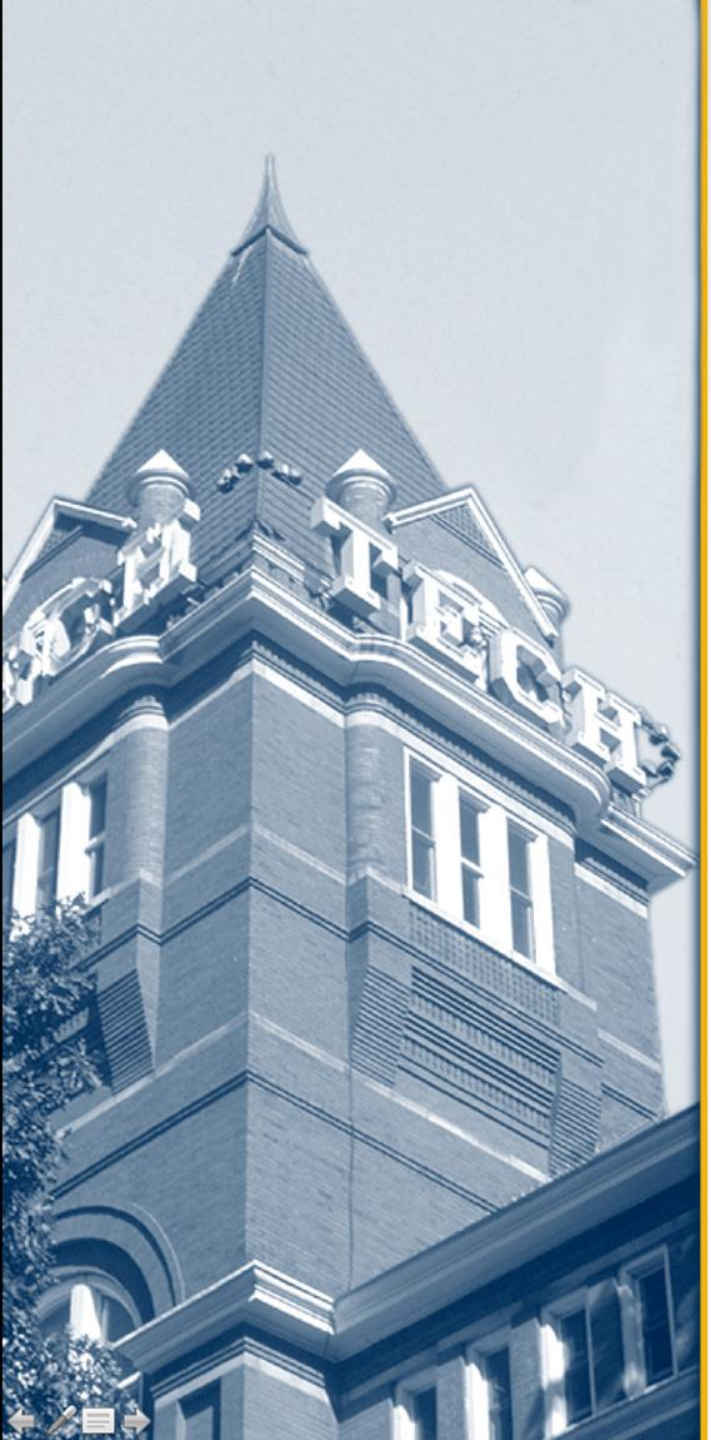
Mar 9th, 2:00 PM - 2:20 PM

Redesigning and Undergraduate Engineering Course

Elise Barrella
Georgia Institute of Technology



Redesigning an Undergraduate Engineering Course into a Learner-Centered Experience

Presenter: Elise Barrella

Georgia Scholarship of STEM Teaching & Learning Conference

March 9, 2012

Georgia Institute of Technology

Context

- Tech to Teaching Program
  - Step 1: Introductory Experience
  - Step 2: CETL 8803TL Foundations of Teaching & Learning
  - Step 3: CETL 8803PR Mentored Teaching Practicum
  - Step 4: CETL 8803CD Course Design
  - Step 5: CETL 8801IMM Teaching Immersion
- Steps 4 & 5: Redesigned and taught CEE 3000 Introduction to Civil Engineering Systems
  - Required course for CEE majors, elective for others
  - ~60 students per section
  - 3 hrs in class per week

Redesign Principles: Integrated & Backward Course Design

Source: L. Dee Fink, *Creating Significant Learning Experiences: An Integrated Approach to Designing College Courses*, 2003.

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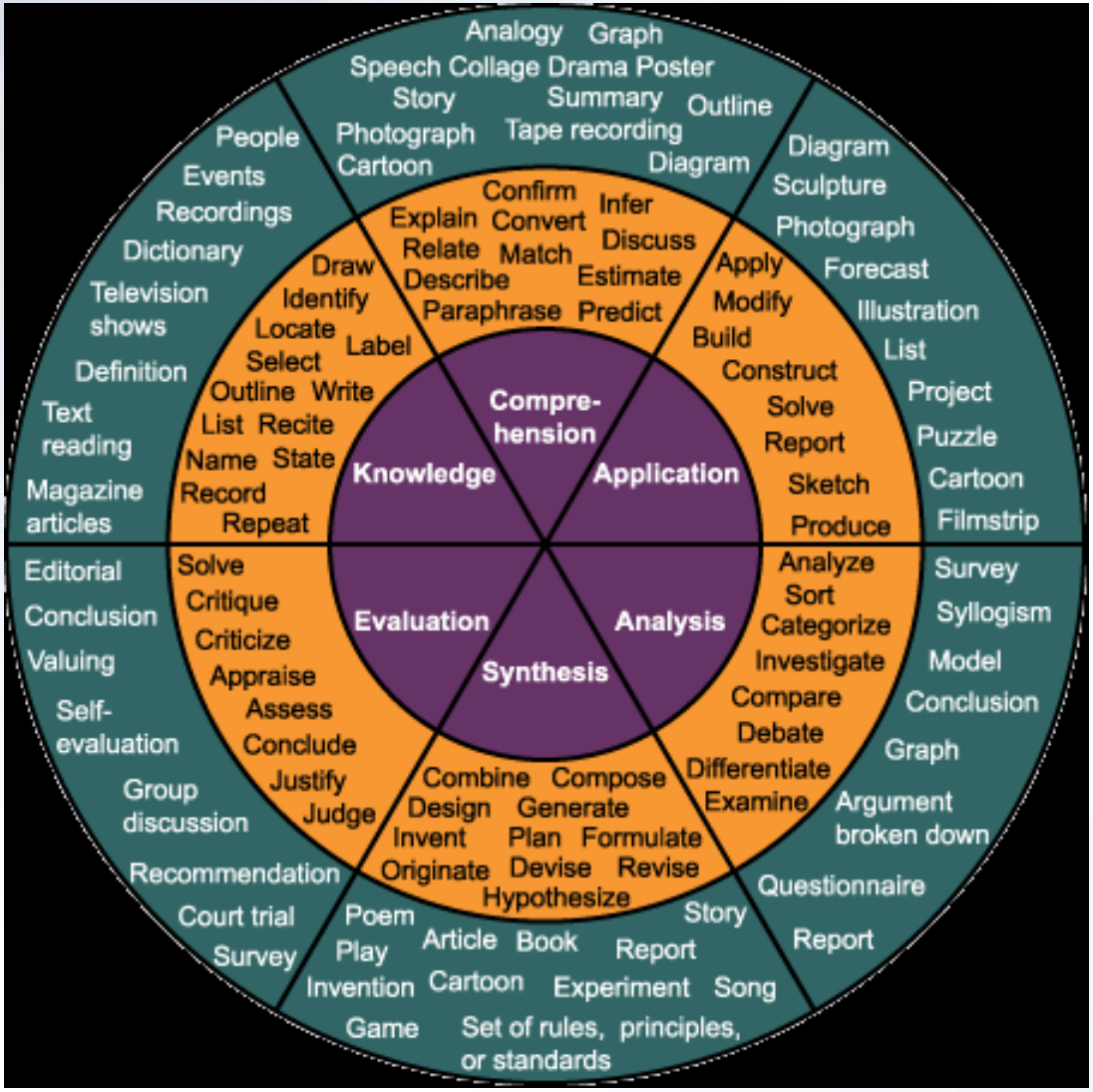
Developing Course Goals



Bloom's Taxonomy

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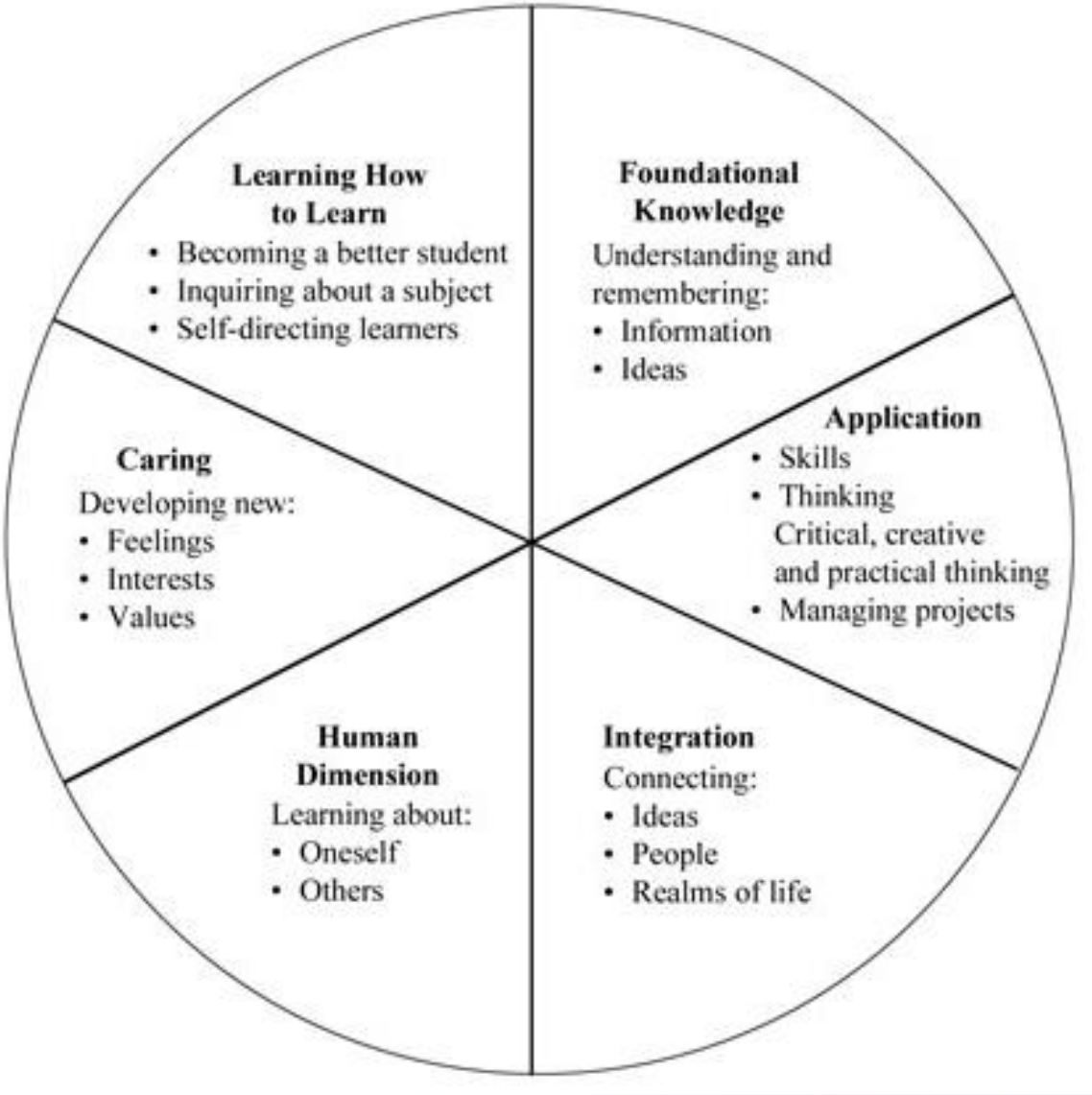
Developing Course Goals (2)



Fink's Taxonomy of Significant Learning

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Course Goals: CEE 3000

By the end of the course, students will be able to…

- **Recognize and communicate** the impact of applying sustainability as a guiding principle for their professional and personal lives.
- **Select and use** economic and engineering analysis tools to evaluate the sustainability of civil engineering projects and proposals based on the triple bottom line: environment, economy, and social equity.
- **Analyze** civil and environmental infrastructure projects using the systems approach to engineering planning and design, and extend those skills to solving engineering problems in future classes and as engineering professionals.
- **Explain** the principles of the civil engineering code of ethics and be able to **debate** the probable ethical implications of an engineering decision.
- **Evaluate** the relevance and reliability of information sources that they identify for class assignments.
- **Demonstrate** basic professional technical communication skills by presenting the findings of their term project through written, verbal, and visual means.
- **Assess** their teamwork skills (time management, communication, cooperation, technical contributions, etc.) and those of group members.

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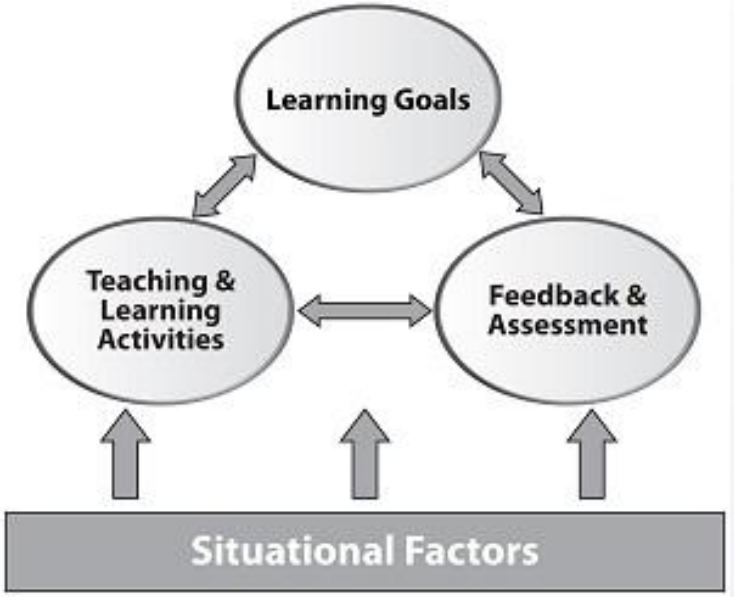
Assessments

- **Homework Assignments (Goals 1, 2, 5, 6)**
- **Communications Assignments (Goal 6)**
- **Exams (Goals 1-4)**
- **Team Project: Infrastructure System Analysis (Goals 1-7)**



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Teaching and Learning Activities

- **Daily Lessons (Goals 1-4):**
  - short lectures with Q&A
  - problem-solving
  - reflection
- **Workshops (Goals 5 & 6):**
  - Communications
  - Library Skills
- **Out-of-class Preparation (Goals 1-7)**

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Minute Papers to Stimulate Self-Directed Learning

- “Every (normal) class period, students will be asked to write and turn in ‘minute papers’, which could cover reading assignments, material discussed in class, or reflection that integrates material from throughout the course. These papers will help me gauge how well you are preparing for class and learning, and if you attend class.”
- Debriefed responses at beginning of next class
- 5% Participation grade
  - “Students must complete at least 80% of the minute papers to receive full credit. Students can earn extra credit by completing 95% or more of the minute papers. A minute paper will be collected at the beginning or end of each regular class period.”

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Same Format, Different Questions

- Diagnostic questions:
  - What is a system? What are the five elements of a system?
  - Indicate whether each statement is true or false: In optimization, the function to be maximized or minimized is called the decision function.
  - Draw and label the cash flow diagram for example problem 2.
  - What are the major differences between arithmetic and geometric gradients?
  - For each example problem: What was the most difficult step or concept? Be specific…
- Reflection questions:
  - What is the muddiest point from today's lesson?
  - What tools/methods (either mathematical or qualitative) can you apply to your team project? Explain why.
  - Why are we studying engineering economy? Why is it important? What is one drawback of focusing on engineering economy?
  - What is the most interesting thing you learned about the other group's topic? After reviewing their draft, what is one thing you will revise in your own draft?

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Did they work?

- Class attendance consistently high – 80% of students completed at least 80% of minute papers; only one student did not receive any credit
- Students made an effort – honest, thoughtful responses; demonstrated preparation
- Students viewed me as approachable, caring about learning because of daily feedback
- Easy to identify common difficulties, misconceptions, opinions, etc. and address them promptly
- Took minimal effort to review, easy to track thus not a burden on my time

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Self-directed learning and Meta-cognition

"The best way to reduce the impact of poor metacognition, is to use formative assessment during teaching. Formative assessments are brief, low-stakes activities that students do in order to give both themselves and the teacher feedback about their level of understanding. There is a wide assortment of assessments that faculty can use, such as think-pair-share activities, minute papers, and so-called 'clicker' questions."

- Stephen Chew, Professor and Chair of the Psychology Department at Samford University. Quoted in article "Meta-cognition and Student Learning" from Chronicle of Higher Education

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Before and After: What is sustainability?

Before…	After…
being able to continue an activity into the foreseeable future.	taking into account all the effects of a project - not just the economic effect but also the environmental and social effects
utilizing resources (natural) in a way that leaves coming generations with the same opportunities	leaving earth in a condition which gives future generations the same opportunities as previous ones while improving standards of living for population
being able to make normal, everyday structures and materials last longer and be more environmentally friendly	being able to build or improve aspects of life (from food to infrastructure) while being the most environmentally, economically, and socially friendly
ability to sustain; ability to stay the same	a balance of profiting, people satisfaction, and leaving our planet the way it is found while completing a goal
I don't really know however, I would guess being able to last or sustain.	ability of a project to sustain; not just physically but also economically, socially, environmentally, and politically

***Sample of actual paired student responses to minute paper question from first and last day of the class**

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