Example of a Well-Designed Course in: ENGINEERING

1. Specific Context

- **The subject matter:** Application of sustainability concepts to engineering
- **The title of the course:** Sustainability Engineering
- **Typical class size:** 10-15
- **Level of the course:** Upper Division (junior/senior standing)
- **Mode of delivery:** Face to face with some blended
- **Type of institution:** University

2. General Description of the Course

Course develops students' abilities to apply the principles of sustainability to engineered systems. Course topics include sustainability and sustainability engineering definition, life cycle engineering, green construction, ecological design principles, and energy and carbon footprint management

3. Big Purpose of the Course

Develop students' knowledge, skills, and attitudes so they can and will strive to use their engineering and other skills to solve sustainability problems.

4. Important Situational Factors/Special Pedagogical Challenge

This course uses project based learning with real projects and stakeholders. Students taking this course have been within the department for 2-4 years. Yet, this course is often the first time when they are asked to deliver a real project and work with real clients in class setting. This change in format and expectations is a challenge because it takes a while for students to understand and manage the non-technical aspects of working through and delivering a project. Many non-technical issues come up as students collaborate with the client/stakeholder towards successful completion of the project. Also, the reality of producing something useful for someone requires more work than submitting something just for class credit. This can lead to some apprehension for some students.

5. 3-Column Table

Use this table below to provide information about these three aspects of your course design.

Learning Goals:	Assessment Activities:	Learning Activities:
Project management and team work skills	Project progress reports, project final report and final presentation	Weekly discussions with students on the actions and strategies necessary for successful completion of the project. Project is launched with the client coming to class. Instructor presents some background information related to project. Then, the client discusses their perspective and students get a chance to introduce themselves and ask their questions to the client in person in class. Project final presentation to stakeholders and to the public also becomes a learning activity on its own as students prepare for a public event.
Ability to perform simple life cycle assessment calculations based on EIOLCA software.	Homework assignment requiring the use of the EIOLCA software.	In class game where students experience first hand some of the basic calculations performed in EIOLCA software. Presentation of life cycle related slides and demonstration of the software by instructor.
Mastery of content related to definition of sustainability and sustainability engineering.	Homework assignment requiring students to answer questions from assigned reading.	Students read assigned work and answer certain questions. The questions are then discussed in class and students' responses turned in for grading.
Ability to evaluate the 'greenness' of products.	Students self pick a product or technology and evaluate its greenness using life cycle	Presentations by instructor on life cycle assessment and sustainability criteria.

	assessment and other sustainability concepts. Students present their work in class.	Students' own research on the product they select. Students discuss with the instructor their product idea and initial findings before presenting their work to class. Grading scheme shows them the criteria they should consider in their work. This assignment is often an individual assignment and students also learn from listening to each other's presentations.

- NOTE: I wrote separate learning objectives for each of the areas within Fink's taxonomy of significant learning. However, I struggled to align these objectives with activities and assessments. Because the project became such a big part of the class, most learning goals and assessment activities seemed to relate to the project. I am now working on redesigning the course so the project and other activities are a little more balanced.

6. Weekly Schedule

Planned Schedule

Date	Discussion topic	In Class Activity	Deliverable for that day
January 10	Intro to sustainability	Presentation by Dr. Apul	
January 12	Intro to sustainability	Presentation by Dr. Apul, discussion of assessment 1	Assessment 1: 2 points
January 17	MLK day - no class	-	
January 19	Greenhouse gas inventory	Discussion of previous UT GHG reports	Assessment 2: 2 points
January 24	Greenhouse gas inventory	Discussion of City of Toledo and Lucas County GHG	Assessment 3: 2 point
January 26	Climate action plan	Discussion of UW and UMaine climate action plan reports	Assessment 4: 2 points

January 31	Climate action plan	Project work, teams prepare for project launch	Nothing
February 2	Launch project	Project discussion, UT-CAPT visits class	Nothing
February 7	Project work	Project work	Nothing
February 9	Global sustainability	Guest speaker: Dr. Lauren Fry	Assessment 5: 10 points
February 14	Life cycle assessment	Intro to LCA presentation by Dr. Apul, teams prepare questions on LCA	Nothing
February 16	Life cycle assessment	Hands on EIOLCA exercise	Nothing
February 21	Life cycle assessment	Hannah presents on EEAST	Nothing
February 23	Life cycle assessment	Water Sustainability, LCA, WE Credits	Assessment 6: 10 points
February 28	General sustainability	Issues with population, food, fossil fuels	Nothing
March 2	Sustainable construction	Intro to sustainable construction and LEED presentation by Dr. Apul, informal feedback	Assessment 7: 5 points Assessment 8: 5 points
March 7	Spring break		
March 9	Spring break		
March 14	Sustainable construction	LEED site visit to UT field house	Nothing
March 16	Sustainable construction	LEED discussion	Nothing
March 21	Sustainable construction	LEED discussion	Nothing
March 23	Sustainable construction	LEED discussion	Assessment 9: 10 points
March 28	Green product	Green product presentation	Assessment 10: 7 points
March 30	Green product	Green product presentation	
April 4	Climate Change	Presentation by Dr. Kumar	Nothing
April 6	Energy calculations	Presentation by Dr. Kumar	Nothing
April 11	Practice	GRI, sustainability reporting, ecological, carbon, water	Final report for mock grading

	presentation	footprints	
April 13		Final report discussion, presentation discussion	Nothing
April 18	Practice presentation	Practice presentation	Assessment 11: 10 points
April 20	Ecological Design Principles	Discussion on biomimicry and ecological design principles	Nothing
April 25	Practice presentation	Practice presentation, fill in bubble sheets	Assessment 12: 10 points
April 27	Final presentation	Final presentation	Assessment 13: 20 points
May 3 Tuesday	No meeting	Submit final report	Assessment 14: 20 points Assessment 15: 5 points
			Assessment 16: 0 points
			Total available pts: 120

Full syllabus is available for download from: http://defneapul.wikispaces.com/Teaching

My teaching strategy is to use a variety of approaches to keep students engaged. These approaches include:

- Share with them a detailed schedule and complete set of assignments at the beginning of class so they can plan their time accordingly
- Assign a real project in class that requires students to meet the needs of a client while working as a team
- I have had students present their final work in a public presentation to the community. This proved to be very helpful in improving the quality of work.
- I limit the amount of time students passively watch me present Powerpoint slides
- I have a hands on activity in most classes.
- I form student teams upfront and give them multiple opportunities to develop their team skills.

- Add 1-2 paragraphs of comments about anything special you needed to do, to make this course work right.

I was interested in real projects since sustainability is an action oriented field. I felt students needed to see that they could make our society 'more sustainable' using their technical and other skills in this class. This project oriented approach seems to have worked well in developing this class. However, the project does take a lot of time and some students seem to prefer covering more content in lieu of learning and practicing team work and project management skills. I am working on finding the right balance that will appeal to most students.

7. Evidence of Impact

This class uses real projects. The projects have an impact on our local community as they address an unmet need while using content and skills learned in class. Students seem to enjoy working on real projects and improving our society this way.

However, they also often struggle with the challenging aspects of working with others. The project is a very different experience than answering simple problems from books. Some results from an earlier graduate level of this course are presented in the following paper:

Apul, D.S. and Philpott, S.M. (2011) Use of Outdoor Living Spaces and Fink's Taxonomy of Significant Learning in Sustainability Engineering Education*, Journal of Professional Issues in Engineering Education and Practice*, 137(2), 69-78.

8. Most Exciting Aspect of the Re-Designed Course for Me (optional)

9. My Contact Information

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