Engage, Empower, and Educate through Service Learning Experiences in the First-Year Seminar Course in Engineering

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***Abstract* - This paper discusses the use of service learning activities to strengthen the student learning experiences in the critical entry-level course, *First-Year Seminar course in Engineering*, for undergraduate engineering majors. The *First-Year Seminar in Engineering* at our institution is offered once each year during the fall term. The redesign of this course was necessitated by the (1) disparate nature of the content from session to session (2) lack of continuity across sessions, and (3) absence of a common thread to bind the content of the course. For the incoming engineering student to receive both the holistic University experience and develop the ability to learn and retain fundamental engineering principles and practices, the course incorporated *community-based engineering projects* as the *core theme*. The students formed teams, and maintained *team*-based *blogs* to document their progress on the engineering project. Rubrics were developed to assess the performance of the students in the engineering projects.**

Index Terms – Service learning, Team blog, Engineering projects

INTRODUCTION

The critical entry-level course at our University, titled *First-Year Seminar in Engineering*, is designed to orient the new student to the University, to introduce engineering as a professional field, to connect with the Liberal Studies Core, to assist in the transition from high school to university life, and to encourage development of academic, personal, and spiritual aspects of the student's life. The First-Year Seminar in Engineering will stimulate and enhance the student's interest in and their understanding of engineering. Unfortunately, the previous offerings of this course failed to deliver the desired learning experiences due to (1) disparate nature of the content and delivery from session to session (2) lack of continuity across sessions (3) absence of a common thread to bind the content of the course.

There are nine course outcomes as listed below. Each course outcome maps to a specific ABET-approved student learning outcome.

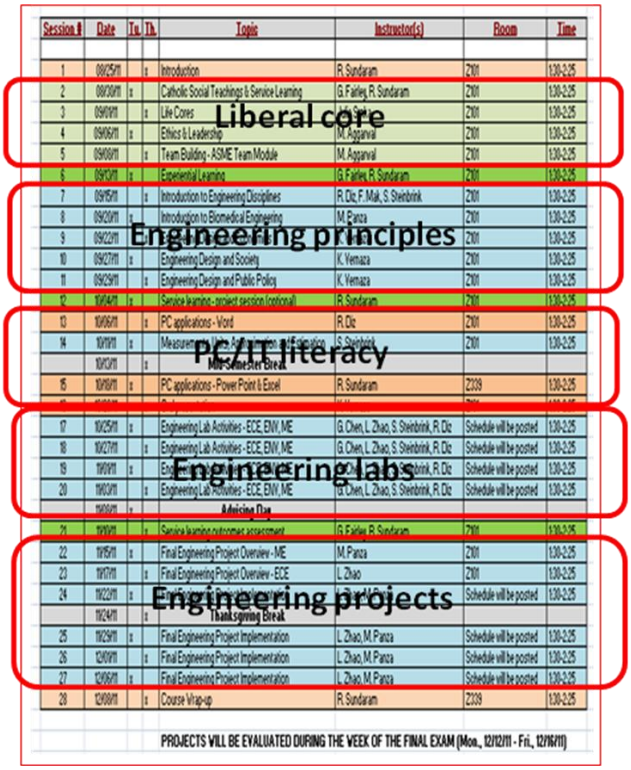
1. Comprehend the basic topics in mathematics, science, and problem solving tools common to the engineering fields
2. Comprehend the engineering design process and problem solving techniques
3. Comprehend how economic, environmental concerns, health and safety, communication, social concerns impact engineering
4. Demonstrate the ability to conduct experiments and analyze data
5. Demonstrate the ability to analyze one of the following LIFECORE dimensions including related activities and presentations: Intellectual (Quest for Knowledge), Life Planning (Balance), Cultural (Appreciation), or Political (Leadership)
6. Demonstrate the ability to relate the following two elements of Catholic social teaching to their own lives: (a) the affirmation of the fundamental rights and responsibilities of every person, (b) the protection of the dignity of work and the rights of workers
7. Demonstrate the ability to analyze what they learned from their engineering service learning experience
8. Demonstrate effective electronic communication and collaboration skills, including the ethical use of computing software and Internet technologies
9. Demonstrate the ability to evaluate personal study habits and develop goals to improve those habits

The primary aspect of the redesign was to deliver the content in modules which focused on a *central engineering project* comprising *service learning components* and *project-based team-managed blogs*. Service learning is of vital importance in the engineering profession [1], [2] and must be integrated into the engineering curriculum at an early stage of career development. Engineering projects with aspects of service learning are both challenging and motivating to students entering the engineering profession after STEM studies at the high school level. In addition to teaching the students engineering design and practice [3] in the context of society and values, and instilling the recognition of engineering issues and concerns, engineering project activity with service learning incorporates reflection and collaboration as the critically required facets of

engineering education. Section 2 provides details of the approach to course redesign. Section 3 identifies the rubrics adopted for learning outcomes assessment. Section 4 summarizes the delivery of the redesigned course and the results of learning outcomes assessment. The conclusions and future plans are documented in Section 5.

SECTION 2: APPROACH TO COURSE REDESIGN

First, the sessions of the course are reorganized to integrate them around a core theme [4]. The course meets in 30 sessions during the term (15 weeks at 2 sessions per week). Figure 1 illustrates the grouping of the sessions as course modules each with the underlying theme as indicated.



Session #	Date	Tu	Th	Topic	Instructor(s)	Room	Time
1	08/25/11		x	Introduction	R.Sundaram	Z101	1:30-2:25
2	08/30/11	x		Catholic Social Teachings & Service Learning	G.Fairley, R.Sundaram	Z101	1:30-2:25
3	09/01/11		x	Life Cores		Z101	1:30-2:25
4	09/06/11	x		Ethics & Leadership	M.Aggarwal	Z101	1:30-2:25
5	09/08/11		x	Team Building - ASME Team Module	M.Aggarwal	Z101	1:30-2:25
6	09/13/11	x		Experiential Learning	G.Fairley, R.Sundaram	Z101	1:30-2:25
7	09/15/11		x	Introduction to Engineering Disciplines	R.Dlz, F.Mak, S.Steinbrink	Z101	1:30-2:25
8	09/20/11	x		Introduction to Biomedical Engineering	M.Panza	Z101	1:30-2:25
9	09/22/11		x	Engineering Design and Society	K.Vemaza	Z101	1:30-2:25
10	09/27/11	x		Engineering Design and Society	K.Vemaza	Z101	1:30-2:25
11	09/29/11		x	Engineering Design and Public Policy	K.Vemaza	Z101	1:30-2:25
12	10/04/11	x		Service learning - project session (optional)	R.Sundaram	Z101	1:30-2:25
13	10/06/11		x	PC applications - Word	R.Dlz	Z101	1:30-2:25
14	10/11/11	x		Measurement [illegible]	S.Steinbrink	Z101	1:30-2:25
	10/13/11		x	Mid-Semester Break			
15	10/18/11	x		PC applications - Power Point & Excel	R.Sundaram	Z139	1:30-2:25
16	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
17	10/25/11	x		Engineering Lab Activities - ECE, ENV, ME	G.Chen, L.Zhao, S.Steinbrink, R.Dlz	Schedule will be posted	1:30-2:25
18	10/27/11		x	Engineering Lab Activities - ECE, ENV, ME	G.Chen, L.Zhao, S.Steinbrink, R.Dlz	Schedule will be posted	1:30-2:25
19	11/01/11	x		Engineering Lab Activities - ECE, ENV, ME	G.Chen, L.Zhao, S.Steinbrink, R.Dlz	Schedule will be posted	1:30-2:25
20	11/03/11		x	Engineering Lab Activities - ECE, ENV, ME	G.Chen, L.Zhao, S.Steinbrink, R.Dlz	Schedule will be posted	1:30-2:25
	11/08/11	x		Advising Day			
21	11/10/11		x	Service learning outcomes assessment	G.Fairley, R.Sundaram	Z101	1:30-2:25
22	11/15/11	x		Final Engineering Project Overview - ME	M.Panza	Z101	1:30-2:25
23	11/17/11		x	Final Engineering Project Overview - ECE	L.Zhao	Z101	1:30-2:25
24	11/22/11	x		Final Engineering Project Implementation	L.Zhao, M.Panza	Schedule will be posted	1:30-2:25
	11/24/11		x	Thanksgiving Break			
25	11/29/11	x		Final Engineering Project Implementation	L.Zhao, M.Panza	Schedule will be posted	1:30-2:25
26	12/01/11		x	Final Engineering Project Implementation	L.Zhao, M.Panza	Schedule will be posted	1:30-2:25
27	12/06/11	x		Final Engineering Project Implementation	L.Zhao, M.Panza	Schedule will be posted	1:30-2:25
28	12/08/11		x	Course Wrap-up	R.Sundaram	Z139	1:30-2:25
				PROJECTS WILL BE EVALUATED DURING THE WEEK OF THE FINAL EXAM (Mon., 12/12/11 - Fri., 12/16/11)			

FIGURE 1
THEMES OFF THE COURSE MODULES

The core theme of the course to link the course and classroom activities to the community is a pool of *engineering projects* with clearly identified *service learning components.* These projects are determined prior to the start of the term in discussions with the Office for Service Learning and the Center for Social Concerns at our University.

Funding was provided to each team for their bill of materials. Student teams were organized and project selections made within the first three weeks of the term. Figure 2 represents the conceptual bridge between course modules and these projects through *team blogs* for reflection and collaboration.

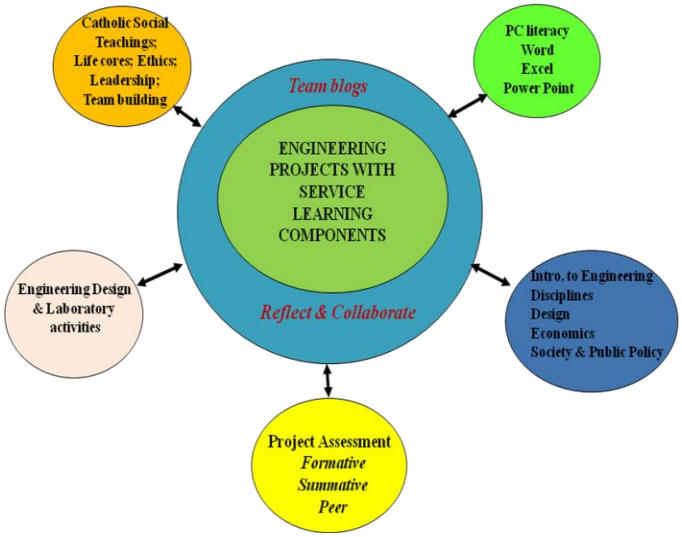


FIGURE 2
CORE THEME, MODULES, AND BRIDGE

Some of the community-based engineering projects are described below.

(a) *Solar-panel installation* (Figure 3)
The team assigned to this project was not required to design but to properly install the available solar panels for maximum energy efficiency.

FIGURE 3
SOLAR PANEL INSTALLATION

(b) *University Community garden fence* (Figure 4)
The team assigned to this project had to design and build the fence to protect the harvest. The design was first approved by the maintenance department at the University. Then, the team obtained the materials for construction.

FIGURE 4
GARDEN FENCE

(c) *Roofing materials for energy-efficient buildings* (Figure 5)
Identify the current roofing materials used on University buildings. Then, research and propose alternate materials to lower heating and cooling bills. Determine suitable paints based on effectiveness, safety, and cost.

ROOFING MATERIALS

(d) *Vermicomposting bin* (Figure 6)
Design and build a composting bin for worms to feed on organic matter such as food waste, paper, and leaves.

FIGURE 6
VERMICOMPOSTING BIN

(e) *C.H.O.S.E.N. Mission project* (Figure 7)
Recondition medical equipment for use in developing clinics.

FIGURE 7
RECYCLE MEDICAL EQUIPMENT

SECTION 3: RUBRICS FOR OUTCOMES ASSESSMENT

The student performance in each course outcome is measured by the pre-selected assignment, called the *key assignment*. The assessment of course outcome #7 (the outcomes are listed in the Introduction), which is specific to the service learning experience, is based on rubrics for the following.

(a) *Team-based blog*
(b) *Formative* (in-class presentation – update)
(c) *Summative* (final report on the core project)
(d) *Peer or internal* (intra-team performance)

The key assignment for course outcome #7 is the final report on the core engineering project with service learning.

(a) *Team-based blog*
The teams assigned to each project identified a team leader who managed the entries made on the *team blog page*. These entries would represent the documentation of the progress of each team on their respective projects during the term. The students had access to course material through the *course blog* which was managed by the instructor. Table I displays the four categories of assessment, the scores assigned to different levels of performance, and the weight of that category in the final score for the *team-based blog*.

TABLE I
RUBRIC FOR ASSESSMENT OF THE TEAM BLOG

OUTCOME ASSESSED	Beginning Score: 1-3	Developing Score: 4-6	Proficient Score: 7-8	Strong Score: 9-10	WEIGHT
Overall Use of Blogs	Blog entries are few and generally simple restatement of personal events.	Blog entries and comments have a logical flow and are well organized.	The blog entries and comments indicate some thought given to reflection however some aspects are overlooked.	The blog entries and the comments indicate significant reflection and substantial contribution.	40%
Intellectual Engagement with Key Concepts	Blog entries make no reference to issues raised through readings and/or class activities.	Blog entries make some reference to issues raised through readings and/or class activities.	Blog entries demonstrate awareness of most of the key issues.	Blog entries demonstrate engagement with the important issues.	25%
Personal Response to Key Concepts	Blog entries show no personal responses are made to the issues/concepts raised in the readings/activities.	Blog entries convey little evidence of personal responses to the issues/concepts raised in the readings/activities.	Blog entries convey some evidence of personal responses to the issues and demonstrate the ability to reflect on learning, technology, and society.	Blog entries convey extensive evidence of personal responses to the issues and demonstrate growth through reflection on learning, technology and society.	25%
Engaged Writing	Blog entries consistently use incorrect grammar and syntax making it difficult for others to follow. No links are included connecting your thoughts to those of others.	Blog entries demonstrate some evidence of correct spelling, grammar, punctuation, etc. Audience will have little trouble reading your blog. An occasional link is included.	Blog entries show a good command of basic English. No problems for the audience. Most blog entries include links.	Blog entries show a very good command of basic English and have some flair and originality. Blog entries may contain multiple links.	10%

The four categories of assessment are as follows:
1. Overall use of blogs
2. Intellectual engagement with key concepts
3. Personal response to key concepts
4. Engaged writing

The score is assigned in the range corresponding to the classification of the content in each category to four levels (beginning, developing, proficient, and strong).

(b) *Formative assessment*
The rubric to assess the in-class presentation by each team (progress report) during the term is shown in Table II.

The four categories of assessment are as follows:
1. Presentation style
2. Team involvement
3. Overall progress
4. Schedule/Timeline provided

TABLE II
RUBRIC FOR FORMATIVE ASSESSMENT

Scoring % / Category	Unsatisfactory(0-60)	Minimal(60-75)	Average (75-90)	Excellent(90-100)
Presentation style	*Lacking in coherent ideas, poorly organized*	*Information not well organized and loosely presented*	*Information conveyed however could be improved*	*Carefully thought out ideas and effective story telling*
Team involvement	*Complete absence of team work*	*Some evidence of team work but not well coordinated*	*Team work lacked some aspects of coordination*	*Highest degree of team work and commitment*
Overall progress	*Absence of any effort and/or evidence of any plan or activity*	*Some effort made but not according to a plan*	*Plan identified and some effort to achieve goals observed*	*Well defined plan and high levels of effort to achieve the goals*
Schedule/Timeline Provided?	*Completely ignored/overlooked in the organization of the project*	*Present but poorly defined stages and timetable for achievement of the stages*	*Timeline included but some unclear or unrealistic tasks scheduled*	*Clearly stated stages and timeline of the components of the project*

The score is assigned in the range corresponding to the classification of the content in each category to four levels (unsatisfactory, minimal, average, and excellent).

(c) *Summative assessment*

The final report submitted by each team at the end of the term is assessed by the rubric shown in Table III.

TABLE III
RUBRIC FOR SUMMATIVE ASSESSMENT

Scoring % / Category	Unsatisfactory(0-60)	Minimal(60-75)	Average (75-90)	Excellent(90-100)
Project overview and goals	*Overview and goals are either poorly stated or not provided at all*	*Overview and goals lack clarity of thought and/or expression.*	*Overview and goals have the essential elements but fail to convey the scope.*	*Overview is very clear and the goals are properly identified.*
Project description & task plan	*Description not provided and tasks poorly and/or not identified at all*	*Description provided but lacks clarity; tasks plan not specific*	*Description and tasks are stated but need more details*	*Description and tasks are clearly stated with details*
Discussion of the project tasks completed	*Project tasks poorly discussed and/or not at all*	*Project tasks completed lack clear enunciation*	*Project tasks completed are clearly stated but some details are not provided*	*Project tasks completed are very clearly stated and all details are provided*
Conclusions & overall organization of the report	*Very poor organization of the project report; no conclusions*	*Some thought given to the overall organization but can be improved; few conclusions*	*Well organized report however with a few discrepancies; only some conclusions*	*Very well organized report with clear evidence of project activity; clear statement of conclusions*

The four categories of assessment are as follows:

1. Project overview and goals
2. Project description and task plan
3. Discussion of the project tasks completed
4. Conclusions and overall organization of the report

The score is assigned in the range corresponding to the classification of the content in each category to four levels (unsatisfactory, minimal, average, and excellent).

(d) *Peer or internal assessment*

The rubric for each team to assess individual contributions to the team project is shown in Table IV. Each member was graded on a scale from 0 (not involved) to 5 (actively involved) for their level of involvement.

TABLE IV
RUBRIC FOR PEER ASSESSMENT

Team Name	
Team Project	

Name of the team member	Team Leader (Yes/No)	Grade the level of involvement Scale: 0 – not involved 3 – moderately involved 5 – actively involved	Remarks

The remaining eight course outcomes are assessed by the construction of the EAMU vectors and their application to the *key assignment* for that outcome. The construction of the EAMU vectors used for course assessment applies the following scoring in all cases: **Excellent** (E) is scoring 90 or better of the total points possible, **Adequate** (A) is 75 or better, **Minimal** (M) is 60 or better, and **Unsatisfactory** (U) is anything below 60. The web-based tool known as *Evaltools*^{R} [5] is used to gather the evidence for the entire class in each class activity.

SECTION 4: DELIVERY AND RESULTS

The redesigned First-Year Seminar course in Engineering was delivered in the Fall 2011 semester (August 2011 to December 2011) at our University. The following highlights of the delivery are noted.

- 51 students were enrolled in the class
- They formed 13 team to work on the six service learning projects identified earlier in this paper (more than one team assigned to the same project)
- Team leaders received training on the creation and maintenance of team blogs
- Teams completed and submitted *peer assessments* each week
- Teams documented their progress on the project using their team blogs
- Teams provided progress reports as part of the *formative assessment* during the term
- Teams submitted the final report and updated the entries on their team blog page
- *Team blog assessment* and *summative assessment* were completed at the end of the term

Figure 8 and Figure 9 display two samples of the entries made by the teams on their team blog page. The teams assigned themselves a team name for use throughout the course. Figure 8 shows the team blog page maintained by the **One Green Team** whose project was to design and build up-cycled fixtures for the café on campus.

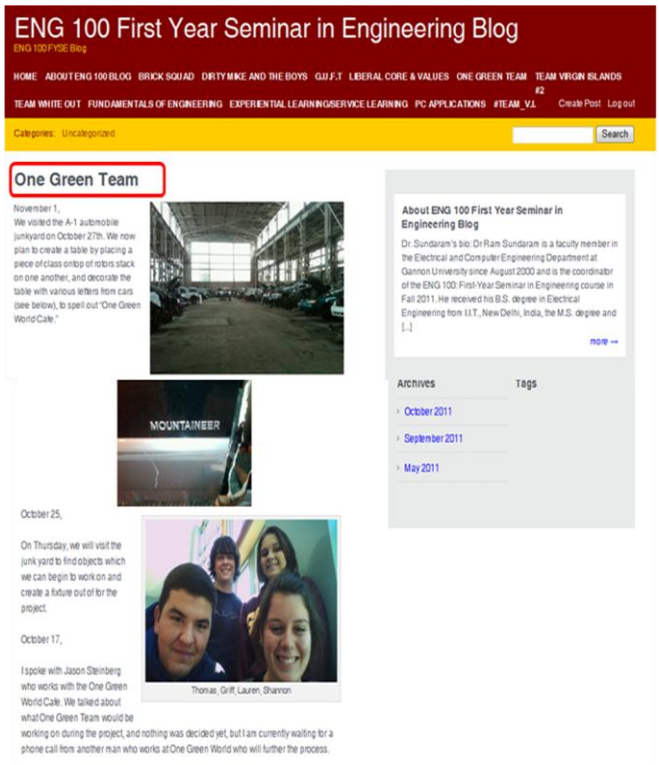


FIGURE 8
TEAM BLOG – I

FIGURE 9
TEAM BLOG – II

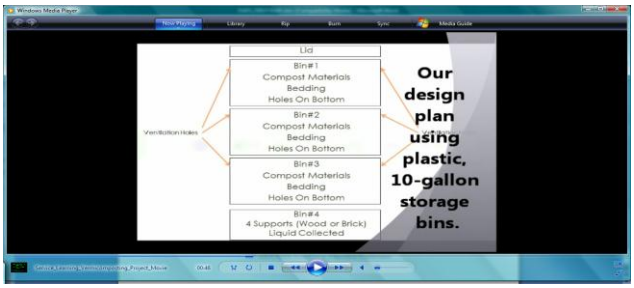
Figure 9 shows the team blog page maintained by the team **G.U.F.T.** (**Gannon University Fence Team**) whose project was to design and build the fence for the University Community garden. Both blogs reveal the multimedia content uploaded by the teams as they made progress on their respective projects.

The teams were given the option to submit the final report using *Windows Live Movie Maker* (WLMM). This option was chosen by about 40% of the teams (5 teams out of the 13 in the class). Sample content of the submission from the team labeled **Team Tiger Blood** (Project: Vermicomposting bin design) is shown in Figure 10.

(a)

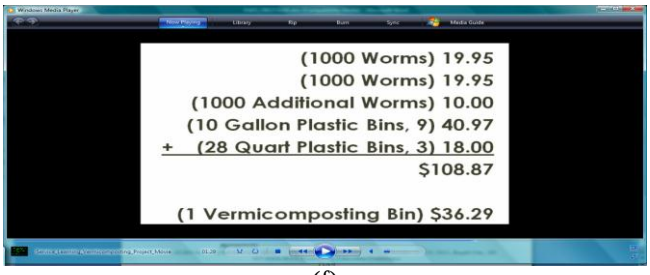
(b)

(c)



(d)

(e)



(f)

FIGURE10
TEAM REPORT IN WLMM – SAMPLE CONTENT

SECTION 5: CONCLUSIONS

The redesigned First-Year Seminar course in Engineering with a central engineering project with service learning components and team blogs successfully met and exceeded the following expectations.

- Related classroom content to engineering problems in the community
- Gave students the opportunity to understand engineering project constraints and requirements in practice
- Helped the students develop leadership and communication skills through team work
- Enabled the students to use the experience to strengthen their preparation for future careers in engineering

The inclusion of innovative instructional and learning tools has a profound impact on engineering education. In the future, the course will be restructured to include a module on project management so that each team is capable of setting goals that can be achieved during the term of fifteen weeks.

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[3] Karsnitz, J. , O'Brien, S., & Hutchinson, J., "Engineering Design – An Introduction," Cengage Learning, First Edition, 2009.

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[5] *Evaltools*^{R}: A Web-based Assessment tool (http:www.makteam.com).