

Putting the Project Back in Project Management Courses

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Introduction:

The skills of Project Management are an essential skill for the engineer of today. Consequently, many engineering programs across the country offer Project Management courses as part of their engineering curriculum. In redesigning the project management course at the University of Miami, we wanted to ensure that students develop skills in not only project management but also working in teams. The literature shows that Project Management Education needs to include a practical, hands-on project where students can use the theory they are learning to plan, manage, and execute a project with real stakeholders. Van der Horn and Killen found in their research in project management education that courses in project management require more than just knowing the theory but rather having “lived experiences” and challenges for effective learning [1]. In addition, input from the university’s and department’s advisory boards demand that students have project management skills that they can employ straight out of school.

As part of redefining the course, we wanted to introduce an element of civic engagement and community service. As engineers, they are part of a community in which they are imparting solutions to make the world a better place. However, the current curriculum doesn’t put it into practice. One of the areas that there are definite deficiencies is recruiting students from underrepresented populations. Most engineering schools have less than 25% female students. In a study published by the US Department of Education, only 21.3% of conferred engineering degrees were awarded to women [2]. There are cultural barriers and an inherent bias in the field against women [3]. This is further noted in a study presented in 2003 women did not see themselves as engineers and their view of engineering did not match what they wanted to achieve [4]. Also, a study in 2022, indicates that the primary reason girls do not choose engineering is because of lack of knowledge and understanding of what engineering is and what they do [5]. As part of the redesign of the project management course, we also wanted to address this societal issue. Having engineers incorporate societal issues into their design work is a requirement of not only our accrediting body ABET, it is a professional obligation according to the Engineer’s Code of Ethics[6, 7]. These two primary issues were the guiding light in the redesign of the project management course.

Why was the Project Management Class redesigned?

One of the primary reasons for redesigning the project management class was a teaching philosophy that students learn by doing and that should apply to project management. By default, project management is an active learning exercise that involves a diverse group of individuals. The literature in project management education supports this underlying personal belief. “Preparing students for professional practice is enhanced by the use of ‘authentic’ tasks and assessments that reflect the practices and outputs encountered in the profession” [1]. In order to be authentic, it needs to be a real executable project. The literature also speaks about the disappointment with practitioners on the skills of students and that has been confirmed with advisory boards in our college.

In addition, students who took the previous version of the course taught by other faculty were sent a survey which asked about the project management course. It was sent to 65 students with

a 25% response rate. Students were asked about the content of the course, the types of assignments that were beneficial and about the “project” that was assigned. Only 30% of the respondents found the course content extremely beneficial and 50% found it moderately beneficial. However, when asked specifically about the project assigned the comments were less than favorable. Over 80% of the respondents found the project not meaningful at all or less than ideal because they were fabricated projects. One student comment was “learning about software isn’t a project that project managers do. Course should be aligned with industry[8]. The sentiment of other students was similar. In addition to the survey, several in-person interviews were conducted with those former students to gather details of how the course was taught and the assignments given.

In addition to surveying and interviewing students who already took the course, one-on-one interviews were conducted with students who would eventually take the course as part of their curriculum. The focus was to determine how best to redesign the course based on student input. Four students were interviewed who were either a freshman, sophomore or junior student. Students were asked to describe a positive learning experience at the college and why. All the students had a recurring theme of experiences of where they had to “do” what they learned and “apply” to a real-world experience. In addition, the students wanted a mix of types of assignments not just exams or a project. With the input from the interviews and the survey that was conducted, the course elements were designed with these themes in mind.

How was the Project Management Class redesigned?

Research in engineering education talks about a framework for engineering projects, the EPS formula [9]. The framework includes a timetable of activities and topics that should occur throughout the semester. It starts with teambuilding/teamwork and then moves to project management topics and theory, and ends with the execution of the group project. With this in mind, the essential topics for the course were reviewed. The learning objectives for the course were as follows:

1. Learn and Apply Project Management Methodology
2. Apply Project Management tools through the execution of a civically engaged community project.
3. Work effectively as a member of a small team with self and peer evaluation
4. Learn how to lead a project and the team members on the project team.
5. Effectively use oral, written and graphical communication techniques in a variety of manners throughout the course.
6. Learn and effectively use Microsoft Project

With these learning objectives as a guide, the following topics for project management were included:

1. Modern Project Management
2. Strategy and project selection
3. Defining the project
4. Project Managers

5. Project Teams
6. Project estimation and scheduling
7. Project constraints and scheduling changes
8. Ongoing progress and performance measurement
9. Project Closeout

The elements that were part of the course redesign were as follows:

- The theoretical topics in the order of the project management cycle.
- Quizzes and homework to ensure technical knowledge
- Comprehensive Civically Engaged Project.

In addition, the class pedagogy was primarily a combination of experiential learning, collaborative learning, and civic engagement with some lecture days for theory. With that the lecture, assignments, quizzes and project activities occurred in the order of the project life cycle so that students were learning, practicing and applying each new stage of the life cycle together. The approach was intended to simulate how you would plan, manage, and execute a project in industry. Previous research showed that experiential learning needed to happen in Project Management to meet the needs and concerns of industry [10].

Along with the topics and part of the redesign, the group project defined for the course included a civically engaged project. The project defined for the course was to plan, manage and execute an event called Girl Scout Engineering Day. The goal of the team project was to have students apply project management techniques using a structured approach to project management that was part of the theoretical learning in the class. The project was designed to provide each team member with the opportunity the experience of being a project manager and also being a team member. In addition, this project was designed to have students engage in a civic activity and give back to the local community of the University of Miami to reinforce that engineers serve the public.

As part of the course structure, theory and practice were introduced and then students were expected to apply the concepts in their semester project. Table 1 below is a course template that shows the phases of the project life cycle with the topics, assignments and project tasks that were designed into the course. For example, as part of the project manager and project teams' topics, students needed to create a project charter, team contract and engage in a team building event. Application with theory was the emphasis. In addition, because of the difficulty of trying to realistically have students "manage the Triple Constraints", an essential Project Management skill, an HBR Project Management Simulation was imbedded in the course. The Simulation provided a project scenario that the students managed in their groups over "15 weeks" (simulated). The simulation required decisions by the students which impacted Scope, Performance and Cost. Once again, an emphasis of practicing "real" project management activities.

Sample Course Template

Project Life Cycle Phase	Topics	Assignments	Project activities and deliverables
Defining	Modern Project Management	In Class Case Study	Project Team formation
		Quiz	Weekly Project Team Meeting with minutes
	Organization Strategy and Project Selection	In-class activity	Project Charter
		Homework	Team Building activity created by each team
		Quiz	
	Defining the Project	Homework	Project Scope
		Quiz	WBS
		HBR Simulation part 1	Resource Matrix
	Being an Effective Project Manager	Homework	
		Quiz	
Planning	Managing Project Teams	Quiz	Communication Plan +/-delta Team evaluation
	Estimating Project Times and Costs		Updated WBS with time estimates Weekly Project Team Meeting with minutes
	Developing a Project Schedule	Homework	
		Quiz	
	Scheduling Resources and Costs	Homework	
		Quiz	
	Microsoft Project Tutorial	Linked-In Learning Intro to Project Management	Project Plan on MS Project
	Managing Risk	Homework	Risk Management Plan
		Quiz	
Executing	Reducing Project Duration	HBR Simulation part 2 & 3	Leveled Project Plan
		Homework	Initial Design Document
		Quiz	Weekly Project Team Meeting with minutes
	Progress and Performance Measurement and Evaluation		+/-delta Team evaluation #2
			Final Design Document
			Project Budget and Supply List
			Weekly Project Team Meeting with minutes
			Activity Posters
			In-Class Mock Execution Day
			Project Event Day-Project Execution
Closing	Project Closure		News Release
			Lessons Learned Team Presentation
			Final Team Evaluation
			Project Portfolio
Additional Topics in Project Management	Outsourcing: Managing Interorganizational Relations	In-class activity	
		Homework	
		Quiz	
	Organization: Structure and Culture	In-class activity	
	Agile Project Management		
	International Projects		

Table 1

Why Girl Scout Engineering Day?

As we discussed in the introduction many girls don't consider engineering because of lack of knowledge, understanding, or access to positive information depicting women in engineering, the project was to plan and execute a "Girl Scout Engineering Day". It ties in with the author's passionate belief that girls need to be introduced and stimulated about engineering at a young age. Research shows that many girls have decided entering middle school that they are not good in Math. Media portrayal influences this image about who is good at math and this becomes a self-fulfilling belief [4]. Current programs to expose and encourage girls into engineering are usually directed at girls starting in Middle School and later. Girl Scouts is an organization that has invested considerable money and effort into encouraging Girls in STEM with their STEM initiatives reflected in badges and journeys at all levels of Girl Scouts. In addition, a project such as this the instructor is the project sponsors and it allows the instructor to control the phases of the project to enhance learning.

The objective/purpose/goal of Girl Scout Engineering day is to have a fun filled afternoon learning about engineering for Girl Scout levels of Daisies (K-1st grade), Brownies (2nd – 3rd grade), and Juniors (4th – 5th grade). The goal is to stimulate a real interest in STEM and specifically in Engineering for girls from K-5th Grade. Currently there are many programs for girls at a Middle School and High School age to introduce them to Engineering. However, research and experience show that girls need to be stimulated and engaged at a younger age in order to pursue higher levels of Math and Science as they enter Middle School [4].

The project

The instructions for the project were as follows: Each team is to plan, design, manage, and execute an afternoon of age-appropriate engineering activities for their group of girls. The activities should be fun-filled and age appropriate. The student teams were not responsible for advertising, registration, collecting fees and securing rooms for the activities. That was done by a student organization. Each team was responsible for everything that would happen in their respective rooms.

Project parameters:

1. Groups of 4 students – faculty assigned
2. Each group will host a group of 8-12 girls in a specific Girl Scout level (Daisies, Brownies, and Juniors) for the afternoon.
3. Each member must be Project Manager/lead for one of the 4 activities they are to deliver.
4. The group is to determine and design the age-appropriate activity. Specific requirements for the types of activities were provided based on Girl Scout programming for "Think Like an Engineer"
5. Weekly team meetings were required with submitted minutes.
6. Project execution was on the day of the event.
7. Project closeout activities which included a Project Portfolio, News Release and a Lessons Learned presentation.

All the requirements for the project were to tie in with applying project management principles and satisfying ABET requirements for teams and communication. The student submissions tied

in with standard project management deliverables including a project scope, communication plan, project plan, weekly status reports, designs for activities, budget and supply list requirements, and a news release. As part of the activity's design and execution, the teams were required to create an activity poster which tied the engineering concepts to the activity the girls would perform. All this was intended to connect the dots for the girls to why engineering is a possibility in their futures.

In addition to these activities, students were asked to perform peer evaluations of their teams. The purpose of the team evaluations was to provide a real experience in evaluating team members strengths and weaknesses. The evaluations served two purposes. It provided students with feedback on their effectiveness on working on teams and it provided an opportunity to practice as a "manager" how to give constructive feedback. Three evaluations were required throughout the semester and they were done in various formats. The first evaluation was a plus/delta type of evaluation done 4 weeks into the semester. The students did one for each teammate and then in their weekly team meeting they had to discuss it with each other. They did the same exercise four weeks later. The final evaluation was part of their last exam, and it involved the students rating their teammates from 1- 10 on the items found in Table 2.

Final Team Evaluation Criteria

Reliability (can be counted on to do assigned part of work)
On time (arrives on time; is present at all planned activities)
Self-motivation (works hard on expected tasks)
Respect for others (listens, speaks in turn)
Quality of assigned work (completes it correctly and to the team's satisfaction)
Decision making (makes appropriate choices; participates in planning activities; takes responsibility)
Communication (keeps team informed of progress and problems)
Teamwork (contributes, participates, shares ideas, helps)
Employability (would you consider hiring this person?)

Table 2

In addition, they had to describe the strengths and opportunities for improvement of their teammates. This information was then summarized and provided to the students in the class for their specific teams. The goal was to be able to evaluate the student's ability to provide effective feedback to their project team (an essential skill for a project manager) and to get effective feedback on their ability to function on a team (another essential skill for a project manager). This proved to be one of the most effective parts of the course's redesign.

As part of the program's ABET assessments for Outcome 5 (working effectively in a team), students are asked to evaluate their team members using an assessment tool that was developed for the entire college. The project management class is one of the courses used to evaluate that outcome. In the 12 years of reviewing student assessments of the Outcome 5 students would provide a very surface assessment and the majority of the assessments indicated high

achievement with very little variation. At the end of the redesigned course , the students were asked to do the ABET assessment. It was the first time for this course that there was a true variation in the assessment scores among the students. It mirrored the assessment that had to do on the exams and reflected the true achievement of the outcome in my belief. This was an unintended benefit of the course redesign.

Effectiveness of the redesign of the course

Students were given a pre-assessment and post-assessment for the course. The questions for the assessment were based on research from a variety of sources [1, 9 – 14]. The questions on the pre-assessment were as follows:

- Have you ever taken any type of Project Management Course?
- At the end of the semester, do you expect to be able to lead and manage a project?
- What expectations do you have for the course?

The results for the first two pre-assessment questions are in Table 3. At the beginning of the semester, most students did not have knowledge or education in Project Management, and the majority expected that knowledge at the end of the semester. From the expectations question, Table 2 shows a summary of the student responses.

Pre-Assessment questions Results (36 students)

Question	Yes	No
Have you ever taken any type of Project Management Course?	13%	87%
At the end of the semester, do you expect to be able to lead and manage a project?	100%	0%

Table 3

Response Summary on "What expectations do you have for the course?"
Learn what it takes (best characteristics and methods required) to properly manage/lead (effectively in a professional way) projects successfully.
Some specific things mentioned: Organization and planning, team work, creative thinking, presentations, process to create a project.
By the end of the semester be able to be a manager in the future.
Improve management and leadership skills.
Be a collaborative class, learn to work in teams

Table 4

On the pre-assessment the students were then asked to assess their knowledge from 1 – 5 (where 1 is not at all and 5 highly knowledgeable/competent) on the following topics:

- Knowledge of Project Management
- Expertise in managing projects
- Expertise in working in teams
- Expertise in managing team members
- Ability to evaluate and critique team members work
- Ability to evaluate and critique team members behavior on the team.

The results are shown in Table 5. The results are consistent with the curriculum in the BSIE program. All students in the course would have taken 2-3 courses which required working on teams and they indicated being knowledgeable about working in teams. However, the Project Management questions indicate that a majority do not feel they are knowledgeable about that topic or skill.

Results from Pre-Assessment ratings

Topic	% of 5	% of 4	% of 3	% below 3
Knowledge of Project Management	0%	6%	49%	45%
Expertise in managing projects	0%	19%	36%	45%
Expertise in working in teams	22%	39%	29%	10%
Expertise in managing team members	19%	32%	36%	13%
Ability to evaluate and critique team member's work	26%	29%	35%	10%
Ability to evaluate and critique team member's behavior on the team	26%	26%	38%	10%

Table 5

In addition to rating topic areas, the pre-assessment asked for “what types of assignments do you expect in a project management course?” The students indicated the following types of assignments:

- Group Assignments/Projects
 - Small projects with different scenarios and presentations
 - Group work in class/assignments
- Case Studies
 - Written and demonstration
- Go to local/small business and improve their processes.

These expectations lined up with the assignments I had designed for the course. In addition to assignments, they were asked about the types of projects they believed they should work on. The responses ranged from large to small projects and they all contained an element of being “real” or applied. From the pre-assessment, it was evident that the projected design of the course was aligned with student expectations.

On the post assessment, the students were once again asked to rate themselves on the same topics from the Pre-assessment. A summary of the results is shown in Table 6. While knowledge of project management increased, it wasn't a 100% for the top rating. On the "Expertise in managing projects", the ratings also showed an improvement, however, students provided a range of improvement from 3 to 5. The most interesting results were in the two categories "ability to evaluate and critique team members work" and "ability to evaluate and critique team members behavior on the team", these results showed a decrease in the highest rating and some of the other rating categories. This also confirms the observation made earlier about students learning to honestly assess their learning and evaluation after learning the theory and application of evaluating team members in the context of being a project manager. If nothing else were looked at, this shows confirms that students need to have more practical instruction and application as it relates to "working effectively on a team" and "managing a team". Chart 1 clearly shows these trends that have been described.

Results from Post Assessment Ratings

Topic	% of 5	% of 4	% of 3	% below 3
Knowledge of Project Management	37%	57%	6%	0%
Expertise in managing projects	26%	37%	28%	9%
Expertise in working in teams	46%	43%	11%	0%
Expertise in managing team members	12%	47%	35%	6%
Ability to evaluate and critique team member's work	2%	37%	40%	3%
Ability to evaluate and critique team member's behavior on the team	29%	20%	37%	14%

Table 6

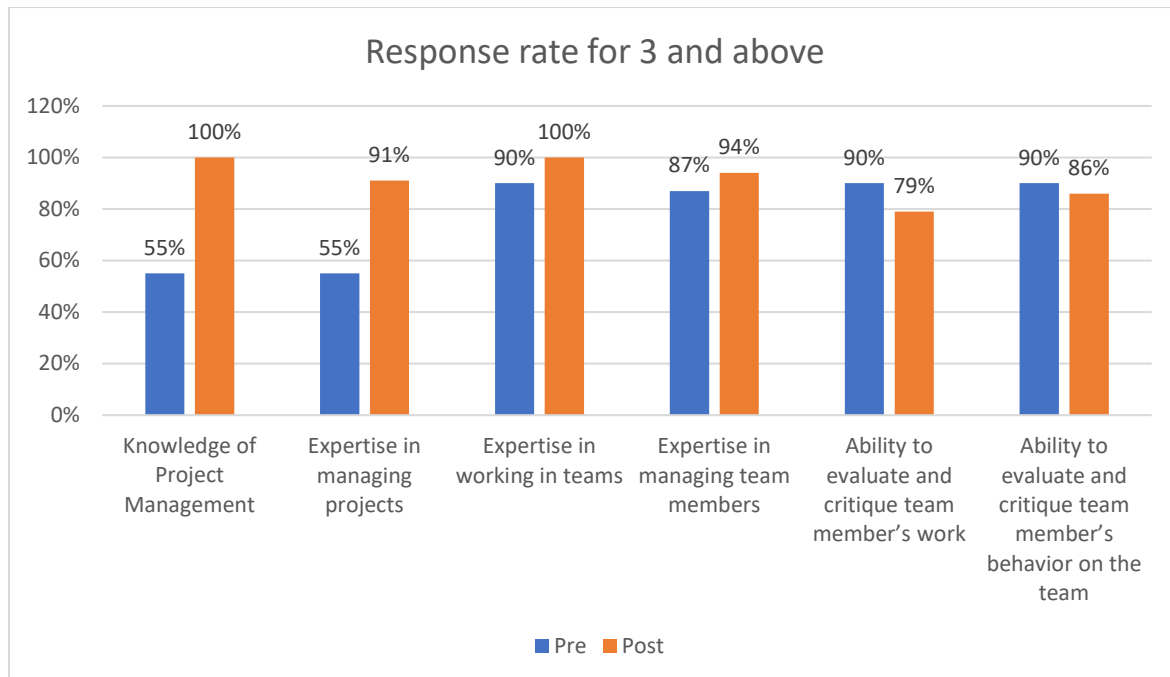


Chart 1

In addition to the post assessment ratings, students were asked to evaluate the course from their expectations, teamwork and the group project. Overwhelmingly students indicated that the course exceeded their expectations. Here is a sampling of student comments as it relates to expectations and learning:

- “My expectations were exceeded. Dr. xx gave informative explanations and real-world examples and the course content was well structured. The combination of lectures, simulations, and hands-on project experience enabled me to gain a thorough understanding of project management principles and their application in various industries.”
- “Before I took this course, I believed myself to be a very outgoing and capable person, so I did not have too much doubt in my leadership skills. However, the course enlightened me in the fact that being a good leader is not only being able to speak in front of others but also communicating effectively. ...I learned there are times when leaders have to be honest with their team members when they are not doing a good job.”
- “It was a course where I can take away soft skills that are hard to teach unless through experiences such as the ones this class provided”
- “I learned that sometimes those who are the best leaders are the ones who know when to also take a step back and let the rest of the group take a leadership role.”

In addition to executing the project, the students were evaluated by faculty and/or TA's as they executed their activities in each “room”. There was an evaluator that graded the students on Execution, communication, adaptability, collaboration and teamwork, and time management. All essential and required skills for the students. The evaluators were given a rubric to use and

they were asked to provide comments. These evaluations served as their “execution” grade and it provided valuable feedback on how they did that day. This was very informative to the students on how they performed that day. This evaluation of student work is unique to this course redesign. The literature and past research did not show that student work was evaluated as they were executing their project deliverable from a live event. However, the evaluation was a strategy in meeting the course objective of knowledge acquisition and practical application of project management skills and working effectively in teams.

Finally, an informal survey of parents, leaders and girls was done at the end of the day. The girls “loved” the day. They all indicated that they wanted to be engineers. That is a hopeful assessment, but the event did meet the course expectations of providing young girls an opportunity to experience what engineering might be. That was an objective for the project from a community perspective and hopefully it leads to more girls considering engineering in their futures. Leaders and parents felt the activities and projects of the day were stimulating and appropriate for the age groups. The course redesign applied what literature suggested and gave it meaning to the students.

Lessons Learned

From the redesign of the course, the biggest lesson to the professor and project management education is that we do not do a good job in teaching how to work collaboratively. The course assessments emphasized that although students believed they knew how to work in groups prior to taking the course; however, they were able to fully understand it takes more than a group dividing activities and completing them. The Divide and Conquer mentality prevalent among engineering students was shown in this course to not be an effective method for team collaboration.

The second lesson learned was that constant and immediate feedback on all submissions with the opportunity to resubmit provided students with feedback that was useful. The quality of the resubmissions improved, and it gave students the ability to work on their weaknesses.

Third, planning a community event without understanding who the intended audience is would be difficult. The professor’s deep knowledge of Girl Scouts and having been a Girl Scout leader allowed the structure of the project to thrive for the community. Consequently, students were able to experience deep satisfaction from giving back to the community and to truly be civically engaged.

Conclusion

Putting the project back into project management with a community service/civic engagement perspective added depth, learning and knowledge to the student population at the University of Miami. It also validated what the literature has been advocating for in Project Management Education. Real world projects with real customers provides an element that cannot be simulated in lectures and homework assignments. Projects must be actionable, messy, and meaningful to really provide learning. The course template shown in the paper would serve as a method that other professors teaching a project management course could adopt.

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