

# Teaching Lean Six Sigma with Service-Learning

Janet M. Braun  
Western Washington University

## Abstract

In learning and applying the Lean Six Sigma methodology and tools, the challenges of clearly defining a problem and then systematically driving down to find the root causes are better experienced than talked about in the classroom.

To improve student learning of this subject, the author incorporated a problem-based service-learning project in the course. Student teams were paired with community non-profit organizations that have no significant knowledge of Lean Six Sigma methodology and little or no resources to spend on process improvement. Each team worked on a unique problem from definition through the recommendation of improvements.

A preliminary assessment was conducted using student surveys. 80% of students agreed that this project helped them see how to apply the Lean Six Sigma tools and methodology and 69% agreed that it helped them better understand the course content. Additional assessment will be conducted by following the 36 students that were in this class through their senior capstone course to determine to what extent they exhibit evidence of learning from this course. Additionally, another class of students will be given the same experience and assessed in the same manner.

Keywords: STEM, Conference Proceedings, Lean/Six Sigma/DMAIC, Teaching Quality

## Introduction

The Lean Six Sigma process improvement methodology and its associated tools are highly pertinent and widely applicable for graduates entering the workforce. Having a thorough understanding of the methodology and how and where to apply each of the tools provides graduates with the flexibility to secure jobs in a variety of manufacturing or service industries as well as the ability to be immediately effective in their new jobs. In learning Lean Six Sigma, there are a couple of challenges that need to be overcome. First, clearly defining and quantifying a problem is difficult. Then, fully understanding the process and generating creative new ideas for improvement can be time consuming and seem redundant. This causes many to rush to implement quick fixes instead of finding the true root causes, therefore failing to solve the problem or improve the process at all.

In the past, Lean Six Sigma tools and methodology were presented in a course, ETEC344 Industrial Quality Assurance, at Western Washington University (WWU) with class examples, homework assignments and a process improvement project assignment. Until now, the author has been discouraged at the students' ability to clearly define a problem and to approach a solution with an adequate amount of depth. Furthermore, use of any of the Lean Six Sigma tools in subsequent courses such as the capstone senior project has been sorely lacking. Even though

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senior projects are widely varied, at least a couple of tools are applicable to each one and would improve the quality of these projects and also provide evidence of student learning. One suspected reason for this gap in student learning is that in the past, students were asked to identify their own process which was in need of improvement for the project assignment. This quite often turned out to be a simple project like making breakfast or getting to school on time and may not have been taken as seriously as it could have.

Service-learning, when integrated into an academic course, becomes “a pedagogical model that connects meaningful community service experiences with academic course learning” (Howard, 1993). It is this connection that was explored recently in ETEC344 to determine if the service-learning component would improve student’s ability to clearly define a problem and to approach a solution with an adequate amount of depth using Lean Six Sigma tools and methodology. This is the topic that will be discussed in this paper.

### **Background**

Service-learning is defined by the Service-Learning Partnership as “a teaching method that engages young people in solving problems within their schools and communities as part of their academic studies or other type of intentional learning activity. Service-learning helps students master important curriculum content by supporting their making meaningful connections between what they are studying and its many applications” ([www.service-learningpartnership.org](http://www.service-learningpartnership.org)). Burns describes this connection further saying that “service learning provides students opportunities to use their acquired skills and knowledge in real life situations in the communities; this enhances teaching by extending student learning into the community and helps foster a sense of caring for others” (Burns, 1998).

Making it appropriate for the objective of this study is Howard’s assertion that service-learning “provides experience with ambiguity and with variance in data significance, both of which in turn foster critical thinking” (1993). Beyond just providing opportunities for learning, research has shown that “students who participate in service-learning describe themselves as more engaged in their work and more motivated to learn, and also report that they have learned more in their service-learning classes than other classes” (National Commission on Service-Learning, 2002).

The many advantages of service-learning are well documented, but so too, are the difficulties and challenges that service-learning presents. In order to provide the most benefit for students, community partners and their service-learning opportunities need to meet properly established criteria. They need to be relevant to the course subject, they need to be of a sufficient duration for learning goals to be met, and the specific activities must “have the potential to stimulate course-relevant learning” (Howard, 1993). Ensuring these criteria are met falls on the shoulders of faculty, but the burden can be shared to some extent with other campus resources. In the case of this study, the Center for Service-Learning at WWU is available to assist faculty in the incorporation of service-learning in their courses and to provide a connection with local community partners.

Implementing service learning can be done through revision of an existing course, as was the case here, or in the addition of a new course. Both of these options require the work of faculty, so the process of creating and implementing service learning curriculum also serves as faculty development (Bringle & Hatcher, 1995). An important step in its implementation is determining the appropriate model for service-learning. Heffernan and Cone describe six models: “pure” service learning, discipline-based service-learning, problem-based service-learning, capstone courses, service internships, and undergraduate community-based action research (2001). Problem-based service-learning (PBSL) allows students to act much as consultants, working with a community client on a particular problem or need making this model very appropriate for the course in this study.

### **Methodology**

To improve student learning of the use of Lean Six Sigma tools and methodology, the author incorporated a problem-based service-learning project in the ETEC344 Industrial Quality Assurance course. The class of 36 students was formed into nine teams of four using CATME Team-Maker (Layton, et. al). The teams were presented with nine vaguely defined community-based projects from six different local non-profit organizations. These organizations, hereafter referred to as the community partners, had no significant knowledge of Lean Six Sigma methodology and little or no resources to spend on process improvement. They were eager to get any help they could, and anxious to see the recommendations from the students.

The teams were asked to rank their top four choices of the projects in an attempt to let each team work on a project that was of particular interest to them. Eight of the nine teams were able to be accommodated and assigned one of their preferred projects. Each team was given contact information for their community partner and one person on the team was the designated point of contact for the community partner to establish a clear channel of communication.

Prior to making contact with the community partners, the students had the opportunity to read about and discuss the Lean Six Sigma process improvement methodology and to practice the use of some of the tools used as part of the Define, Measure, Analyze, Improve and Control (DMAIC) phases of the methodology on two team homework assignments. The first assignment was to complete a Quality Function Deployment on a product of their choice. The second assignment was to use Lean Six Sigma process knowledge and problem solving tools to generate as much knowledge as possible about a problem/process in order to identify root causes. Most of the tools, such as affinity diagrams, cause and effect diagrams, input-process-output maps, cause maps (why-why), how-how diagrams, and workflow diagrams, are qualitative in nature and therefore very applicable to the types of projects provided by our community partners.

Thorough feedback was provided on these assignments and the basic requirements for the project were established as follows (condensed in consideration of space):

1. Work with a community partner to complete the Define – Measure – Analyze phases of DMAIC, resulting in suggestions for improvement.

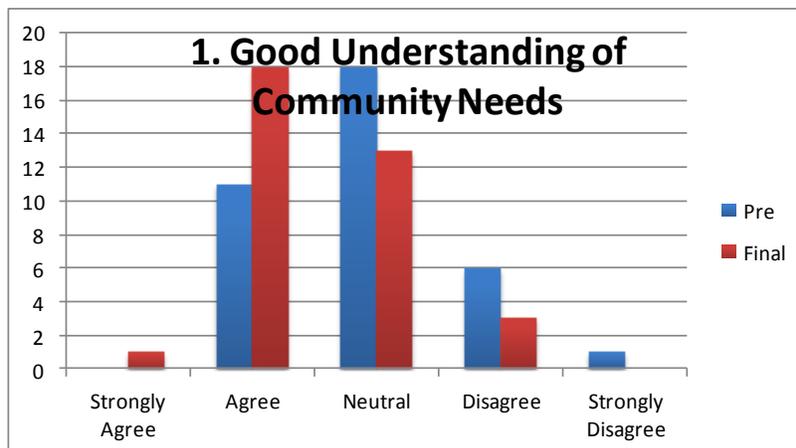
2. Define and quantify the problem, giving a brief presentation of this in class for feedback during second week.
3. Analyze the problem or process using the most appropriate tools to determine root causes.
4. Suggest improvements/countermeasures that link directly to root causes.
5. Use an A3 to report the project, with an interim presentation in class for feedback.

The project spanned approximately five weeks with one additional update during class for feedback, and culminated with a presentation to the class and the community partners. In order to complete a preliminary assessment of the impact of the service-learning projects, a brief survey was filled out by the students just before beginning the projects. This survey was developed and administered by the Center for Service Learning at WWU. This survey asked for students’ opinions on six statements about community service. Immediately after completing the projects, the students were asked to fill out a more comprehensive survey, which is included in Appendix A. This one repeated the same six statements from the first survey, but included several more to gauge the extent to which the project helped students learn the course material. The results can be found in the next section.

Further assessment, of a longer term nature, will be conducted by following the students from this class through their senior capstone course to determine if the tools and methodology are being utilized beyond the course where they are initially taught. This information is expected to become available within the coming year.

### Findings

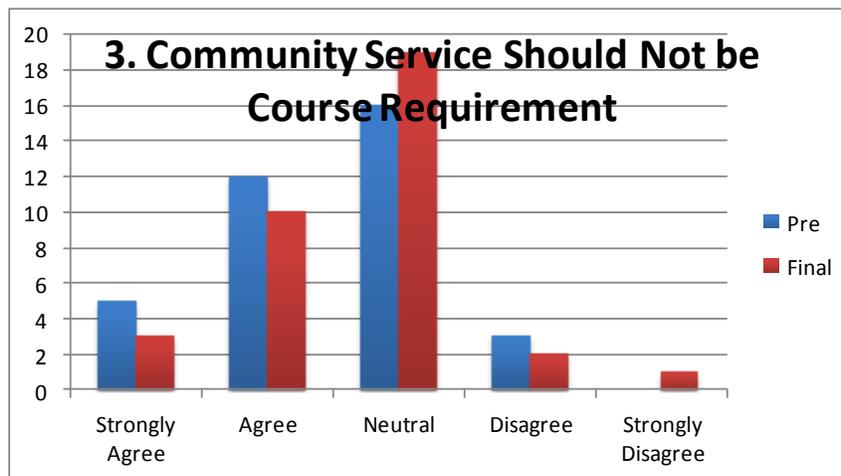
The surveys provided a set of statements to which the students were asked to mark their level of agreement: strongly agree, agree, neutral, disagree, or strongly disagree. The first six statements were identical on both surveys and dealt with attitudes about and understanding of community service.



**Figure 1: Survey responses to the statement “I have a good understanding of the needs and problems facing the community in which I live.”**

The first statement was used to gage whether awareness of community needs and problems increased as a result of the service-learning project. As shown above in Figure 1, 77.5% more students felt that they had a good understanding after the project than before.

Another interesting component from this set of statements was how students felt about doing a mandatory community service project as a course requirement. Before the project, 47.2% agreed or strongly agreed that community service should be voluntary, not a course requirement, and 8.3% disagreed. At the end of the project, only 37.1% agreed, indicating that the students' feelings towards doing a required community service based project became less negative after their service-learning experience. Figure 2 shows these results graphically.



**Figure 2: Survey responses to the statement “Community service should be a voluntary activity, rather than a course requirement.”**

The survey at the end of the project included several additional statements pertaining to service-learning as well as addressing the question of whether the projects helped students learn and apply the course material. Four statements related specifically to the learning of course material are listed below with a summary of the responses. Figure 3 shows the breakdown of responses (level of agreement or disagreement) by statement number graphically.

7. *“My service-learning experience helped me better understand the course content.”*

68.6% of students either strongly agreed or agreed with this statement, 14.3% disagreed or strongly disagreed, and the remainder was neutral.

11. *“The service-learning experience in this course helped me see how the subject matter I learned in class can be applied.”*

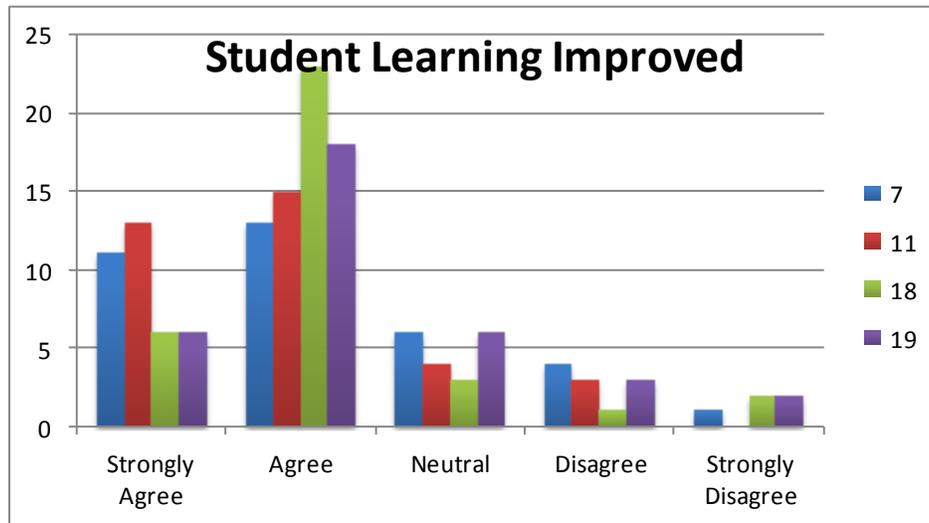
80.0% of students either strongly agreed or agreed with this statement, 8.6% disagreed and the remainder was neutral.

18. *“My ability to work cooperatively and collaboratively with others has improved through my service-learning project.”*

82.9% of students either strongly agreed or agreed with this statement, 8.6% disagreed or strongly disagreed, and the remainder was neutral.

19. *“I gained skills through service-learning that I will use in my future career.”*

68.6% of students either strongly agreed or agreed with this statement, 14.3% disagreed or strongly disagreed, and the remainder was neutral.



**Figure 3: Responses by statements related to improved student learning.**

Beyond indicating agreement with statements, the final survey also gave the students the opportunity to comment in their own words on how the service-learning experience enhanced their overall learning in the course. The author was overwhelmed by the number of positive comments! A few examples are included below that represent the type and tone of these comments.

*“It was nice to apply what I have learned to an actual problem and define it myself. What I learned this quarter I could use and this made me understand even more why we use and how to use the quality assurance tools. It also is more real life experience, not just dealing with hypotheticals.”*

*“Service-learning definitely made me take the course material more seriously. Actually using course content in a community project made the course material come to life and seem more relevant.”*

*“It gave meaning to the material covered in the classroom. It also acted as a venue to practice the material covered in such a way that creativity and critical thinking are necessary.”*

*“Service-learning gave me an actual application for the material I learned in this class, more than regular hands on, this showed me how to use these tools in the real world.”*

*“It felt good to use the skills learned in class to help a local non-profit that does such good work in the community. There was much more genuine incentive to do a good job for them rather than merely getting a good grade in the class.”*

### **Summary**

In summary, this was the author’s first attempt at employing an problem-based service-learning project in a course. The reason for attempting this was to improve student learning of the tools and methodology of Lean Six Sigma which can be very useful in a wide variety of applications. With the help of the Center for Service-Learning at Western Washington University, teams of students were paired with community partners in need of problem solving and process improvement skills. The teams first defined the problem, and then analyzed it to find root causes, and finally made recommendations for improvement. Although final assessment will be made when the students from this class progress through their senior capstone projects, preliminary assessment indicates that the incorporation of this service-learning project may have improved student learning of Lean Six Sigma concepts.

### **Conclusions**

Based on the findings of the preliminary assessment, service-learning shows promise of being an effective method for improving student learning of Lean Six Sigma tools and methodology. The findings are too preliminary at this point, however, to draw a definitive conclusion. In order to draw a conclusion, a problem-based service-learning project will continue to be a part of this course and additional assessment will be conducted to determine if the concepts learned in this course are evident in future work from these students.

### **Future Work**

Additional assessment will be conducted by following the 36 students that were in this class through their senior capstone course to determine to what extent they exhibit evidence of learning from this course. Specifically, the correct use of Lean Six Sigma tools and/or methodology will be considered evidence of learning. Additionally, another class of students will be given the same experience this spring and assessed in the same manner, with the addition of a critical reflection exercise mid-way through the service-learning project. Reflection is recognized as a method of enhancing academic learning in a service-learning experience (Howard, 1993) (Bringle & Hatcher, 1995).

### **Acknowledgements**

The Center for Service-Learning at Western Washington University was instrumental in this project. They enthusiastically supported this effort and a great deal of the credit for its success is due to them. Our community partners also deserve acknowledgement for participating in this

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new endeavor and opening their operations up to relatively inexperienced student teams. All involved agreed that it was a worthwhile experience.

## Appendices

### Appendix A: Post-Service Survey

1.	I have a good understanding of the needs and problems facing the community in which I live.*
2.	I have a civic responsibility to become involved in my community.*
3.	Community service should be a voluntary activity, rather than a course requirement.*
4.	I currently have a strong commitment to volunteering in the community.*
5.	I have a good understanding of what service-learning is.*
6.	Service-learning should be implemented into more classes at Western.*
7.	My service-learning experience helped me better understand the course content.
8.	I had an opportunity to reflect on my service-learning experience and its relation to the course through assignments and discussions.
9.	The professor clearly related my service-learning experience to course content.
10.	I feel I would have learned more from the course if more time was spent in the classroom instead of the community.
11.	The service-learning experience in this course helped me see how the subject matter I learned in class can be applied.
12.	I did not have a clear understanding of the goals/objectives of my service-learning project.
13.	I feel that my service-learning experience benefited the community partner organization.
14.	I feel that the work I did through service-learning benefited the community at large.
15.	My community partner organization is a good placement site for service-learning students.
16.	I will continue involvement specifically with my service-learning site.
17.	I probably won't volunteer or continue community involvement after this course ends.
18.	My ability to work cooperatively and collaboratively with others has improved through my service-learning project.
19.	I gained skills through service-learning that I will use in my future career.
20.	My service-learning experience has assisted me in clarifying my career plans.
21.	My service-learning experience has improved my ability to be a leader.
22.	I have a better understanding of what service-learning is after completing this course.
23.	If I had the opportunity, I would do service-learning again.
24.	How did your service-learning experience enhance your overall learning in this course?
25.	Which course concepts did you learn most about through your service-learning experience?
26.	What are the most important things you learning in your service-learning project?

\* Statements also included in pre-service survey.

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### Author Information

Janet Braun is an Associate Professor and the Program Coordinator for the Manufacturing Engineering Technology program at Western Washington University. She has been teaching for six years. For the seventeen years prior to that, Braun held a variety of engineering and operational management positions at Oshkosh Corporation, PACCAR Inc., and Twin Disc, Incorporated. She holds a BSME and MSME from Marquette University and an MBA from Cardinal Stritch University, both in Milwaukee, Wisconsin.