e-Journal of Business Education & Scholarship of Teaching
Vol. 10, No. 1, 2016, pp: 85-93.
"http://www.ejbest.org"

Instructional Note

Using Group Projects to Teach Process Improvement in a Quality Class

Robert O. Neidigh
Shippensburg University
1871 Old Main Drive
Shippensburg, PA 17257
Email: roneid@ship.edu
Phone: 717-477-1233

ABSTRACT

This paper provides a description of a teaching approach that uses experiential learning to teach process improvement. The teaching approach uses student groups to perform and gather process data in a senior-level quality management class that focuses on Lean Six Sigma. A strategy to link the experiential learning in the group projects to the theory provided in class is detailed, specifically the ability to increase yields through centering the process and decreasing variation. The group deliverables linking experiential learning to theory are described and examples are provided. Also, assessment criteria for the group deliverables are suggested.

Keywords: supply chain management education; quality improvement; student assessment; group projects; empirical research.

JEL Classification: I21
PsycINFO Classification: 3550
FoR Code: 1302; 1503
ERA Journal ID#: 35696

Introduction

A required major course in the Supply Chain Management major at Shippensburg University is “Quality Management and Continuous Improvement”. The Six Sigma methodology is introduced as the main driver of continuous improvement. Many Six Sigma tools are taught with emphasis placed on how the tools are used to aid in yield improvements.

One of the concepts that students learn in this course is that the yield in a process can be increased by ‘centering the process’ and ‘decreasing variation’. ‘Centering the process’ refers to adjusting the process so that the process mean is moved closer to the midpoint of the upper tolerance limit (UTL) and lower tolerance limit (LTL). ‘Decreasing variation’ refers to decreasing the spread of the part measurements around the mean. The spread is calculated using standard deviation so essentially decreasing variation means decreasing the value of standard deviation.

This paper introduces an experiential, group learning exercise that is used in the “Quality Management and Continuous Improvement” course to illustrate continuous improvement. The students use the Six Sigma tools to determine methods that lead to yield improvements. The exercise enables students to monitor the process mean, standard deviation, and yield of the processes over time and therefore experience yield improvements as the process is centered and process variation is decreased.

Literature Review

Project-based learning has long been used to enhance student knowledge. Blumenfeld, Guzdial, Krajcik, Marx, Palincsar, and Soloway (1991) present an argument for why projects have the potential to help people learn. Hau (1996) formed a student team to improve teaching in the class thereby teaching a method of quality improvement. Crabtree, Disney, and Harrison (2000) argue that quality management needs to be taught at the undergraduate level. Snee (2000) notes that Six Sigma training using projects is more effective than traditional statistical courses. Anderson-Cook, Hoerl, and Patterson (2005) provide an overview of a project-based course in Six Sigma at the master’s level. Goh, Ho, and Xie (2006) attempt to study the feasibility of integrating the Six Sigma framework into the existing quality engineering education.

The amount of research in teaching Six Sigma concepts in college courses has increased in the past ten years but is still not extensive. Ramos (2014) notes that only a limited discussion on how to teach Lean Six Sigma is available in the literature and proposes replacing traditional passive, in-class lectures with an interactive approach known as the ‘flipped classroom’. Mergen and Stevenson (2006) select projects that reduce costs to teach Six Sigma concepts in an undergraduate business class. Castellano, Petrick, Vokurka, and Weinstein (2008) use group projects in process improvement in local companies to teach Six Sigma concepts in an MBA class.

Cudney has published the most research on using projects to teach Six Sigma. Cudney and Guardiola (2010) note the importance of practical application in teaching Six Sigma concepts. Corns, Cudney, and Kanigolla (2013) employ project-based learning in Six Sigma methods. Corns, Cudney, Kanigolla, and Samaranayake (2014) use projects with local companies to enhance engineering student learning of Lean and Six Sigma. Cudney and Kanigolla (2014) quantify the impact of project-based learning on students’ knowledge in Six Sigma and find a positive impact.

The research that has been performed supports using projects to enhance student learning in Six Sigma.

Learning Objectives

The goals of this group project are:

- Students learn how to use Six Sigma quality tools to attempt to increase yields
- Students learn to make adjustments to a process to attempt to increase yields
- Students experience how centering the process and decreasing variation lead to an increase in yields

Implementation Guidelines

Information Taught Prior to Start of Project

Students are taught how five Six Sigma tools can be used in continuous process improvement. The tools are check sheets, histograms, scatter plots, Ishikawa diagrams, and Pareto analysis. These tools can be used during the project to aid in process improvement.

Students are also shown, through theoretical yield calculations of a normally distributed process, how centering the process and reducing variation increases yields. This provides the students with the knowledge needed to make adjustments to their processes in order to increase yields.

For example, assume the following parameters of a part and its production process:
UTL = 20
LTL = 16
Midpoint of UTL and LTL = 18
$\mu = 19$
$\sigma = 1.5$
The yield in this process is 72.48%.

In order to illustrate how centering the process increases the yield, let us change the process mean to 18.5 so the mean is closer to 18. Now we have:
UTL = 20
LTL = 16
Midpoint of UTL and LTL = 18
$\mu = 18.5$
$\sigma = 1.5$
The yield in this process has increased to 79.36%.

In order to illustrate how decreasing variation increases the yield, let us decrease the standard deviation to 1. Now we have:
UTL = 20
LTL = 16
Midpoint of UTL and LTL = 18
$\mu = 18.5$
$\sigma = 1$
The yield in this process has further increased to 92.7%.

Group Project Design

Groups of four students are formed. Each group identifies a process that they can perform and an acceptable tolerance range for the process. For example, one of the groups putted a golf ball with an acceptable tolerance range of 120 ± 12 inches. The wider the tolerance range then the higher the yields will be and vice versa, however the width of the tolerance range is not typically relevant to the success of the project. The goal of the project is to improve yields, not achieve high yields, so it is not relevant whether the process achieves high yields or low yields.

The group performs the process 120 times each week, 30 times for each member. The yield is calculated for all 120 measurements and for each member's 30 measurements. The process mean and standard deviation are also calculated for all 120 measurements and for each member's 30 measurements.

After each week's performance, the groups meet to analyse the results and evaluate past adjustments to the process that were made to attempt to increase yields. The groups identify possible changes to the process to elevate yields the next time the process is performed. The five Six Sigma tools can be used to aid in the process improvement.

Each week, the groups send their results and process adjustments to the Professor. The groups continue to perform the process and evaluate results for eight consecutive weeks.

Group meetings with Professor

At least two times throughout the eight week period, the groups meet with the Professor to discuss and monitor results. The Professor uses these meetings to guide process improvement through the use of the Six Sigma tools and general questioning of the individual and group techniques. The Professor tries to drive development of a standardized, repeatable technique that provides repeatable results near the target mean, thus leading to a centering of the process and a decrease in variation. The focus of these meetings is on the development of these techniques. Past data is used to monitor improvement or lack thereof.

Group Deliverables

The project description with the three deliverables is provided in Appendix I. Deliverable 1 is a collection of files showing how the five Six Sigma tools, and any other applied tools, were used in process improvement. In class, each group was instructed to use all five Six Sigma tools, at a minimum, so each group should show how each of the five tools were used.

Deliverable 2 should be a run chart plotting the yield for the group and each member over the eight week period. Appendix II provides an example of one of the run charts.

Deliverable 3 should be two charts tracking the yield changes throughout the eight weeks as the process mean varies and the standard deviation varies. Appendix III provides two examples. The first graph shows yield changes over the eight weeks and also shows the difference between the process mean and the target value of 60. As the difference decreases, the process is better centred. The second graph shows yield changes over the eight weeks and also shows the standard deviation each week.

Assessment Criteria

Assessment of Deliverable 1 is based upon the proper use of the quality tools, not a necessary increase in yields. Each of the five Six Sigma tools; check sheets, histograms, scatter plots, Ishikawa diagrams, and Pareto analysis; is worth three points. Three points are earned if the tool is applied in a proper situation and correctly used. Points are deducted if the tool is improperly applied and/or incorrectly used. Some points can be earned at the discretion of the Professor for additional tools that are properly applied. The maximum points earned are 15.

Assessment of Deliverable 2 is based upon the inclusion of the five graphs, one for the group and one for each of the group members. One point is earned for each graph. Points are deducted if the graph(s) does not properly depict the yield changes over the eight weeks and/or is not correctly labelled.

Assessment of Deliverable 3 is based upon the demonstration of how the changes in the process mean and standard deviation over the eight weeks affect the yield. One point is earned for each of the 10 graphs, two for the group and two for each of the four group members. Points are deducted if the graph(s) does not properly depict how yield is impacted over the eight weeks and/or is not correctly labelled.

References

Anderson-Cook, C., Hoerl, R., & Patterson, A. (2005). A Structured Problem-solving Course for Graduate Students: Exposing Students to Six Sigma as Part of their University Training, *Quality and Reliability Engineering International*, 21, 249-256.

Blumenfeld, P., Guzdial, M., Krajcik, J., Marx, R., Palincsar, A., & Soloway, E. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning, *Educational Psychologist*, 26, 369-398.

Castellano, J., Petrick, J., Vokurka, R., & Weinstein, L. (2008). Integrating Six Sigma Concepts in an MBA Quality Management Class, *Journal of Education for Business,* 83, 233-238.

Corns, S., Cudney, E.A., & Kanigolla, D. (2013). Employing Project-based Learning in Six Sigma Education, *The Journal for Quality and Participation*, 36, 34-38.

Corns, S., Cudney, E.A., Kanigolla, D., & Samaranayake, V.A. (2014). Enhancing Engineering Education using Project-Based Learning for Lean and Six Sigma, *International Journal of Lean Six Sigma,* 5, 45-61.

Crabtree, Helen, Disney, John, and Harrison, Peter (2000). The Case for Undergraduate Education in Quality Management, *Total Quality Management,* 11, 574-580.

Cudney, E. A., & Guardiola, I. (2010). Importance of practical application in the teaching of Six Sigma concepts, *ASQ Higher Education Brief,* 3(No.6).

Cudney, E.A. & Kanigolla, D. (2014). Measuring the Impact of Project-Based Learning in Six Sigma Education, *Journal of Enterprise Transformation*, 4, 272-288.

Goh, T.N., Ho, S.L., & Xie, M. (2006). Adopting Six Sigma in higher education: some issues and challenges, *International Journal of Six Sigma and Competitive Advantage*, 2(4), 335-352.

Hau, Ian (1996). Teaching Quality Improvement by Quality Improvement in Teaching, *Quality Engineering,* 9, 77-94.

Mergen, A. & Stevenson, W. (2006). Teaching Six Sigma Concepts in a Business School Curriculum, *Total Quality Management & Business Excellence,* 17, 751-756.

Ramos, M. (2014). 'Flipping' the Lean Six Sigma classroom, *International Journal of Six Sigma and Competitive Advantage*, 8(3-4), 227-246.

Snee, R. (2000). Six Sigma improves both statistical training and processes, *Quality Progress*, 33, 68-72.

APPENDIX I

Project I

30 points
Due Date: Oct. 29 at end of day
Tools:
Check sheet
Histogram
Scatter plot
Fishbone diagram
Pareto analysis

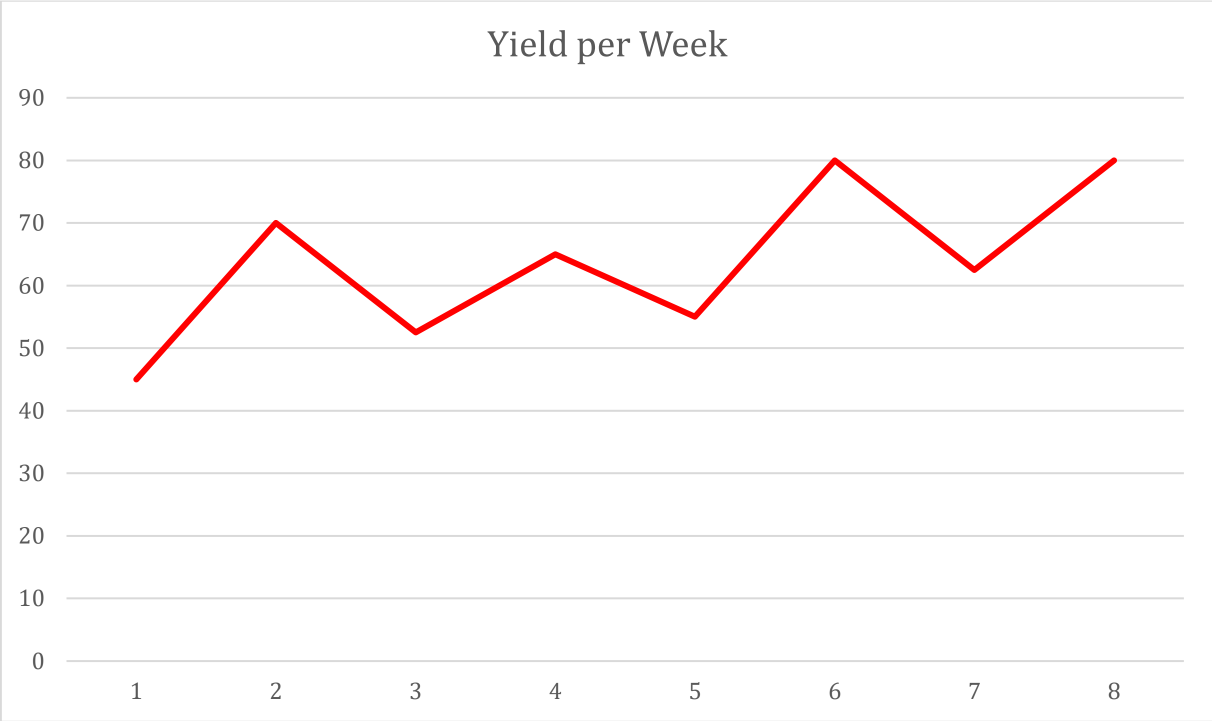
We increase yields in a process by centering the mean and decreasing variation. Your goal is to increase the yields in your process. Using the above tools, and any other tools you feel are applicable, attempt to increase yields.

Deliverables:

1) **Provide evidence of all tools used in your process improvement efforts. (15 pts)**
2) **Show your yields throughout the eight weeks for the group and each member. (5 pts)**
3) **Demonstrate the effect that changes in process means and standard deviations have on yields. Discuss the effects or lack thereof. (10 pts)**

Deliver all files via Digital Dropbox

APPENDIX II



APPENDIX III