Development of Enhanced Analytical Soft Skills via Project Based Learning

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Abstract

Analytical soft skills are vital for project-based learning students. According to Woodware et al. (2010), students that graduate from a project-based cohort group are more marketable upon graduation and finding a job is easier since they possess technical and soft skills such as "interpersonal communication, teamwork, time management, planning and organizational skills". A questionnaire is distributed to 100 randomly selected students enrolled at the University of North Texas (UNT) cohort two in the BS Project Design and Analysis for the Project Based Learning (PBL) pedagogy as the experimental group and three colleges at the UNT Denton campus as the control group. The objective is to measure the growth of analytical soft skills in the PBL based on the project-based learning in the connections class of Collaborative Thinking by using the Randomized Pretest – Posttest Control Group Design (Fraenkel et al, 2019) research methodology.

Introduction

Project based learning (PBL) is an instructional method that is significantly different from traditional teaching methods and relies heavily on students to work autonomously typically in teams for goal setting, collaboration, communications, etc. PBL emphasizes student self-discovery where the faculty play more of a role of a facilitator versus that of a lecturer in helping the students learn by solving real life problems. Research on PBL provides several recommendations for an educational institution to transition to PBL and one of the first ones to tackle as organizations initiate PBL is to create analytical soft skills in the PBL students such that

they can work effectively in a team, identify project problems, gather information, brainstorm ideas, communicate solutions, etc..

The University of North Texas (UNT) Frisco campus, launched UNT's first PBL cohort program for First Time in College (FTIC) in fall of 2019 where 22 freshmen students started as a cohort working on a transportation project by working with the City of Frisco (COF). Almost all the classes that the students graduate in three years by taking 16 hours per semester and three summers, these students attend almost all the classes such for the semester as English, Psychology, Collaborative Thinking and History together and work in the same teams of four to five students that have been defined for the semester. The curriculum is integrated with joint assignments allowing students to get a better and deeper understanding in the course material being taught and aligned to the transportation project for the semester. We divided the cohort students into five teams of four to five students per group and all the students work on an assigned industry project such as looking at transportation challenges by working with the City of Frisco to provide them with a recommendation at the end of the semester. The connections class for the first semester focuses on building the analytical soft skills in the students by leveraging the six-sigma methodology as part of the curriculum allowing the students to build these skills that they will use every semester as needed to be successful in the PBL environment.

Students that graduate from a project-based cohort group are more marketable upon graduation and finding a job is easier since they possess technical and soft skills such as "interpersonal communication, teamwork, time management, planning and organizational skills" (Woodward et al, 2010), which is a plus compared to other candidates applying for the same job. Caudron (1999) mentions, that the information science department in universities should graduate students that had a large knowledge base when it comes to the hard skills and expertise

in communicating with others and project work which are the soft skills needed). The definition of project-based learning is "students are placed in teams and given a project with clearly defined goals and parameters. Students learn that their individual success is dependent on their team's collaboration, not simply individual effort. Drawing from a strong pedagogical foundation that combines experiential learning, the design process, cooperative learning strategies, and the dialogic analysis of case method, this instructional module encourages the development of soft skills and offers a much more organic learning experience than the more traditional combination of lecture and lab time" (woodward et al, 2010).

This paper explores how analytical soft skills could be enhanced in project-based learning students. A questionnaire consisting of 27 questions will be distributed to approximately 30 to 90 students that would be part of Cohort two in the BS Project Design and Analysis degree starting in Fall 2020. The current plan is to have Cohort two have a minimum of one section of 30 and maximum of three sections for a total of 90 students. Our objective is to measure the growth in analytical soft skills in the cohort students based on the project-based learning in the connections class.

Literature Review

Many employers want "college graduates who have "soft skills," such as being a good listener or thinking critically, but they have difficulty finding such candidates" (Bauer-Wolf, 2019). According to Krause (2009), "A comment made by one manager was "people should already have these skills". The consensus was that communication skills should have been developed in college and on the job". Project based learning aids students while in the program to build on their soft skills and enhance them at the same time, that is why students graduating

from the project-based learning program are more well-rounded and guarantee a job upon graduation from the program.

A survey was done among various companies and the result was the "most in-demand talent among employers was listening skills -- 74 percent of employers indicated this was a skill they valued. This was followed by attention to detail (70 percent) and effective communication (69 percent)" (Bauer-Wolf, 2019). What was also interesting is that around 73 percent of the employers mention that it was difficult finding skilled candidates and approximately one-third of the employers (34 percent) state that colleges and universities should have prepared students for jobs that require soft skills, according to Bauer-Wolf (2019). It is clear that having soft skills is vital in today's job market and that it is a plus for students to graduate with such skills, "There is a need for more soft skills training, both in college and on the job, and today's learners and graduates must continue to hone their skills to stay ahead,"(Bauer-Wolf, 2019).

The teams of students in a project-based learning setting, must have good communication, research, design, and technical skill sets in order to succeed. By introducing sign sigma to students, it will aid impact in developing soft skills in project-based learning settings. By "providing students with a framework for working effectively as a team that relies heavily on the concepts of Six Sigma will lead students to working better and more efficiently. As such, six sigma focuses on "delighting your customers with speed and quality, improving your work processes, working together for maximum gain, basing decisions on facts and data" (Krause, 2009).

According to Ellis, Kisling, & Hackworth (2014), there is a universal agreement that soft skills are needed for the employers on for each job and organization, and they could improve the soft skills of the employers that are required for the majority of client services jobs by providing

them soft skills course training. “University of Phoenix in 2005 made a survey for 330 executive managers , and they found that 96% percent of them believed that communication and interpersonal skills as the most valuable employee skills, while 95% rated learning aptitude and desire to grow, where 93% showed collaboration, and teamwork at 93%, while creative problem solving was 92%” (Cline, 2005).

Another relevant employer survey conducted in (2006) by the Conference Board and others entitled “Are they really ready to work?”, four participating organizations together surveyed over 400 employers across the United States. These employers rated the skill sets that new employed, who graduated from high school, two-year colleges or technical schools, and four-year colleges, need to succeed in the workplace. It founds that four top important skills for all three levels of educations that cited by employers in order were: professionalism/work ethic, oral and written communication, teamwork/collaboration, and critical thinking/problem solving (Lotto & Barrington, 2006; Kyllonen, 2013).

Project-based learning helps students to show their higher ability, and instructors could observe student's creativity through implementing projects. Improving creativity produces innovation that enhance students’ satisfaction (Sousa, 2012). Different researchers have found significant improvement in several soft skills through PBL such as student collaboration, creativity, achievement, and teamwork. Ummah & In’am (2019) measured the improvement of students’ creativity in project-based learning when they create a mathematics media learning, they also compare the change of storyboard of learning media with the final project result. It resulted in an improvement of the student’s creativity in completing the project of creating mathematics learning media based on the 3 major aspects: flexibility, originality, and novelty.

Another study conducted by Wurdinger & Qureshi (2015), investigates the improvement of some soft skills include time management, responsibility, problem solving, self-direction, collaboration, communication, creativity, and work ethic in the graduate students who enrolled in PBL course. A survey measured the eight skills by answering the following questions two times one before taking course and another time at the end of the course. “how does your project affect your life outside of school, what makes this project important to the community or world around you, what help from other instructors or experts might you need, and what are three different resources you will use to complete the project?”(p.281). After comparing two results of the students’ scores, the result indicated that there was a significant improvement in the student skills. The study also concluded that PBL is an effective methodology, and it succeeded in engage college students to learn based on their interest.

Despite the many benefits of project-based learning, there are significant challenges in implementing the PBL pedagogy including faculty that is well versed being a facilitator, teaming with companies to bring real projects into the class room, dividing the students into team such that they all effectively work as a team, the perceived conception of higher cost in education due to smaller class sizes, etc. A couple of ways to justify the use of PBL in higher education is by reducing the decrease in student dropout rate which according to College Atlas, “70% of Americans will study at a four-year college, but less than two-thirds will graduate with a degree, and 30% of first-year students drop out after their first year of school”. and employment rate or admission in professional colleges (such as Medical and Law) at a higher rate due to soft skills gained via PBL pedagogy of education.

The University of North Texas (UNT) at the Frisco campus, launched a new degree BS in Project Design & Analysis in Fall 2019 with one cohort of 22 students which will expand by the Fall of 2020 to 120 students where the students will work in four simultaneous cohorts of 30 students each. These students will have also be selecting one of the four available minors of Pre-Med, Pre-Law, Applied Technology and Digital Marketing. These minors were developed by working with the all the different colleges at the UNT main campus in Denton that house the different departments like Political Science, Biology, Chemistry, Computer Engineering and Marketing.

Critical Thinking is a connections class that will be common across all the cohorts in the first semester were fundamentals of teamwork and analytical skills will be deployed to all the students as they learn to work in small teams while working on real company projects. The purpose of this study is to examine the impacts of developing analytical soft skills by working in small teams in the PBL pedagogy with learnings from six sigma in the critical thinking class over the course of a semester. The study was designed to answer the question, does working in PBL pedagogy of working in teams with critical thinking provide improved analytical soft skills for FTIC in higher education.

This research shows how project-based learning could improve the analytical soft skills of Cohort program students in the connections class. In this study, a questionnaire consisting of 27 questions, related to teamwork, information gathering, problem definition, idea generation, evaluation and decision making, implementation, and communication, will be distributed to 50 students that would be part of Cohort two in the BS Project Design and Analysis degree starting

in Fall 2020 for the PBL pedagogy and 50 students that would be enrolled in the traditional education enrolled at the UNT main campus.

Some key terms used in this research include the following:

Project based learning (PBL) defined as a teaching method where teachers guide students through a problem solving process which includes identifying a problem, developing a plan, testing the plan against reality, and reflecting on the plan while in the process of designing and completing a project (Wurdinger, Haar, Hugg, & Bezon, 2007, p. 151).

Soft Skills; are any skill that can be classified as a personality trait or habit include interpersonal skills and communication skills which are more specific categories of soft skills that many employers look for in job candidates (Heckman, & Kautz, 2012).

Cohort Program; based on the dictionary definition is “a group of people banded together or treated as a group, and “cohort programs consist of a small group of students with the goal of working together and providing support to one another throughout this process”(Sousa, 2013, p.253).

First Time in College (FTIC); is a student who has never been admitted to a degree program at an institution of higher education prior to the semester under consideration.

Connections Class; is a set of 6 class for the UNT Project Based Learning Cohort program that allows students to build connections within themselves and with business partners. These classes

include emphasis on Collaborative Thinking, Professional Communications, Team Creativity, etc.

Methodology

The total number of students in the study is 100 in which the experimental group in the study included a random sample of 50 students from Fall 2020 semester from the four cohorts enrolled in the BS Project Design & Analysis degree cohort program at the UNT Frisco enrolled with minors identified as Pre-Med, Pre-Law, Applied Technology and Digital Marketing. The control group included a random sample of 50 students on the UNT campus enrolled in majors such as Biology, Chemistry, Political Science, Computer Engineering and Marketing.

The 50 students that were randomly selected in each of the experimental and control group had a similar end goal of either getting admission in a Law or Medical school or be gainfully employed upon graduation in technology or marketing. Approximately 85% of 120 hours needed to graduate would be the same between both the experimental and control groups with the exception that experimental group will be taking 6 connections classes and working in PBL pedagogy with real clients project each semester in small groups settings of four to six students per group.

In the experimental group, the students were selected from four simultaneous cohort groups of approximately 30 students each where the students were further divided into six teams of four

to six students each. In each of the four cohorts, all the students in the cohort have a blocked schedule where their classes are pre-scheduled for them and they attend the classes as a cohort in small groups of 30 students each. All the cohorts work on an industry project which is built into the curriculum of all the classes that they are taking such as English, History, Philosophy, Collaborative Thinking (Connections), etc. and work with the industry partner to work on a project that has been assigned to them and will provide six different team perspectives to the industry partner at the end of the semester as a final project presentation. Additionally, all the students in the cohort attend a weekly three hour applied seminar where they interact with industry partners for eight weeks in the semester either to present the project or get perspective from different industry leaders as freshmen while the other 8 classes are focused on building life skills such as stress management, branding, etc. and led by Student Services at UNT. In the connections class the students get exposed to six-sigma methodology in terms of working as a team, conducting meetings, collecting and analyzing data for applying the skills on the project.

In the control group, the students are enrolled in different colleges or majors such as Biology, Chemistry, Political Science, Marketing and Computer Engineering at the UNT main campuses in Denton. The students do not have a blocked schedule, they work with the advisors to design a graduation plan initially and then work with advisors again to schedule the classes on their own based on schedule and availability. On the main campus, some of the Texas CORE classes such as history could have in excess of 200 students in the same classroom and there is no continuity that we have the same students in all the classes allowing students in the control program to build a bigger network of friends. Academic Affairs does provide students with opportunities to attend lecture series where industry leaders are invited to speak on the main campus while Student Services also provides seminars on life skills but the students do not receive a grade for attending

these seminars so they do not have the same incentive for attending these seminars even if their schedule allowed them to attend. The randomized pretest – posttest control group design for the PBL pedagogy at UNT with a total of 100 random student with 50 in the Experimental and 50 in Control group is shown in figure 1 below that identifies the treatment applied to experimental group while both experimental and control group will take the same analytical soft skills questionnaire.

Figure 1: Randomized Pretest – Posttest Control Group Design (Fraenkel et al, 2019)

100 Students Random	R	O	X	O
	Random 50 students from New College with the PBL Pedagogy from UNT Frisco campus	Pretest: Analytical Soft Skills Questionnaire (Dependent Variable)	Treatment: Integrated classes with PBL Pedagogy including Connections class	Posttest: Analytical Soft Skills Questionnaire (Dependent Variable)
	R	O	C	O
	Random 50 students from various colleges in non PBL Pedagogy at UNT Denton Campus	Pretest: Analytical Soft Skills Questionnaire (Dependent Variable	Treatment: Regular teaching methodology without Connections Class	Posttest: Analytical Soft Skills Questionnaire (Dependent Variable)

All the students in the study were communicated that the university is conducting a research to measure the development of analytical soft skills across multiple colleges to improve university processes to serve the students better in learning these skills. By participating in this study, the students will be helping future generation of students in developing better analytical soft skills faster and would need to complete one survey at the beginning of the semester and another one at the end of the semester. 10% of the students that successfully complete survey 1 at the beginning of the semester and Survey two at the end of the semester will receive a $25 via a random drawing.

Consent forms were provided to all participants before the study began and included information in regard to the purpose of the study, the procedure, the benefits and possible risks taking part of this study, and the contact information of all the researchers involved in the study.

Type of Study

This study is an experimental design study with the randomized Pretest-Posttest control group design where two groups of subjects are used in the experimental and control group, According to Fraenkel et al, (2019) the randomized posttest-only control group design "differs from the randomized posttest-only control group design solely in the use of a pretest. Two groups of subjects are used, with both groups being measured or observed twice. The first measurement serves as the pretest, the second as the posttest". Both groups will be measured twice where the first measurement is the pre-test and the second measurement is the post-test. The measurements will be conducted in both groups at the same time.

A sample diagram for the randomized pretest – posttest control group is shown below with a sample of 11 students from the 100 selected for this research are is shown (partially) in Table 1 below.

Table 1: Sample Student Participant Demographics (Fraenkel et al, 2019)

Student	**College of**	**Major / Minor**	**Campus**	**Gender**	**Methodology**	**Standing**
1	Liberal Arts & SS	Political Science	Denton	M	Traditional	Freshmen
2	Sciences	Biology	Denton	F	Traditional	Freshmen

3	Sciences	Chemistry	Denton	M	Traditional	Freshmen
4	Engineering	Computer Engineering	Denton	M	Traditional	Freshmen
5	Business	Marketing and Sales	Denton	F	Traditional	Sophomore
6	New College	Pre-Law	Frisco	F	Traditional	Freshmen
7	New College	Pre-Med	Frisco	M	PBL	Freshmen
8	New College	Pre-Med	Frisco	M	PBL	Freshmen
9	New College	Applied Technology	Frisco	F	PBL	Freshmen
10	New College	Digital Marketing	Frisco	F	PBL	Freshmen
11	New College	Applied Technology	Frisco	M	PBL	Freshmen

Research Problem

Analytical soft skills development can vary significantly in similar degree programs at the same university based on the learning pedagogy that is being used to disseminate the education.

Hypothesis

Students that are enrolled in Project Based Learning (PBL) pedagogy develop better analytical soft skills then students enrolled in traditional methods of higher education.

Research Questions

Do the first time in college (FTIC) students develop better analytical soft skills in cohort based Project Based Learning (PBL) pedagogy of learning versus traditional pedagogy over the course of their first semester when enrolled in similar degree programs such in sciences, marketing and technology at the same university?

Instrument

This paper explores the impact of PBL pedagogy on developing soft skills for students enrolled in project-based learning cohort program by using a self-administered paper-based survey. The survey is based on a survey conducted by Gentili, et al in 2005, which was administered to the students to gauge their reaction to and perspectives of team-based projects and case studies. The scale used is a five-point scale (five being the highest and the lowest on the scale) with 27 questions surveying key aspects of teamwork and project management skills. The survey questions include: five questions that measure teamwork; three questions will measure information gathering, five questions will look at problem definitions, five questions on idea generation, three questions on evaluation and decision making, three questions on implementation, and eight questions on communication (appendix A). The "Class Emphasis" category in this instrument allows student to rate skills that are covered in the course to compare the growth of students. both "Class Emphasis" and "Personal Growth" categories provide a way to rate how effective the class is in developing specific skills (Gentili, et al., 2005; Woodware et al.,2010).

The Qualtrics based pretest survey will be conducted at the beginning of the semester in weeks four and five and then again the posttest survey will be conducted towards the end of the

semester in weeks 14 and 15 by researchers that would work with the UNT Frisco connections class faculty at Frisco campus and faculty from departments of Biology, Chemistry, Political Science, Marketing, Computer Engineering to come to class as a reminder and by providing the opportunity for the students to take the survey online. Once the students complete the second survey, the students will be provided an opportunity to enter their names in the drawing for Starbucks gift card ($25 value) where 10 students will receive the gift card for a total investment of $250 for this research.

Validity & Reliability of Instrument

Validity

The survey being used has validity and an effective assessment tool, it has been used to measure students' development of communication, teamwork and engineering design process skills in introductory engineering design classes. In this study, it will measure the development of the team analytical soft skills in project-based learning. According to the previous researchers who used this survey, the results from this survey correlate well with all of the other assessments that have been administered to students who have taken similar introductory design courses.

Reliability

Based on the previous studies that used this survey, many versions of the survey have been used over the last years. To measure the reliability coefficient, they used test retest strategy, and the results generated from the survey are consistent with pre- and post-testing.

Population

The population of the study are the total student population enrolled in the PBL cohort program at the UNT Frisco Campus.

Sample

The total population that is expected for the experimental group is 120 students in the PBL cohort program based on the recruiting efforts for Fall 2020. The total sample size for the traditional students on the Denton campus is expected to be about 2,000 students based on the historical enrollment of freshmen for the colleges identified in the control group. The anticipated breakup between males and females is 50%-50% in the experimental group and 60%-40% in the control group. The random selection of 50 FTIC undergraduate students from PBL cohort program at the UNT Frisco campus will be part of the experimental group from the four concurrent cohorts started in Fall 2020. These students will be part of the BS Project Design and Analysis with an emphasis or minor in Biology, Chemistry, Political Science, Marketing or Computer Engineering. The random selection of 50 FTIC undergraduate students enrolled in the traditional learning methodology at the UNT Denton campus will be from majors / minors such as Biology, Chemistry, Political Science, Marketing or Computer Engineering were the control group.

Variables

The independent variable of the study is the presence of the PBL pedagogy in the experimental group and lack of presence of PBL pedagogy in the control group while the dependent variable is development of analytical soft skills in FTIC students at UNT.

Data Analysis

The analysis of the survey will be done in SPSS to review the results of the data collected for both the experimental and control group for the following key factors on a scale of 1 to 5 to see if there is improvement towards the end of the students first semester at a University in the experimental and control group. The data will then be compared at an aggregate level between the students enrolled in both the experimental and control group to see if the data supports the

hypothesis that; Students enrolled in Project Based Learning (PBL) pedagogy develop better analytical soft skills then students enrolled in traditional methods of higher education.

1. Teamwork
2. Information gathering
3. Problem definition
4. Idea generation
5. Evaluation and decision making
6. Implementation
7. Communication

Limitations

The data collected as part of the project for analysis is a small sample size of 50 students enrolled in the various colleges at UNT main campus and the PBL cohort program at UNT. The survey will be conducted 2 times over the course of the semester.

Threats (Internal & External Validity)

Internal

The quality of instruction and experience of the faculty facilitating the connections class to the students would have an impact on the growth of soft skills in the cohort students.

External

- The cohort program is fairly new at the UNT Frisco campus and limited to four cohorts of 30 students per cohort for a total of 90 to 120 students in Fall 2020 for the program which is a fairly small sample size. If we cannot get almost 50% of the students to participate in the survey then the team results will be very hard to analyze.

- Getting enough FTIC students and colleges to participate from the four colleges identified from the UNT main campus as part of the survey.
- Mortality challenge also exists for students that might drop out of the traditional and PBL pedagogy degree programs at the main campus or the cohort program before the end of the first semester since research data suggest approximately 30% of the FTIC enrolled in college do not finish college.

Examined Descriptive

The statistical analyses will be based on a sample of 100 students attending the University of North Texas. The surveyed students will be enrolled in the project-based learning program at UNT Frisco or in four different colleges at UNT campuses in Denton. The pretest survey will be distributed at week 4 and the posttest survey was distributed in week 10 in the fall semester of 2020 via Qualtrics and reminders will be sent out in the classroom by collaborating with the professors teaching classes. The collected surveys will be from males and females.

The data that will be collected is quantitative data, the data that will be measured is done by using a five-point scale which will indicate how much of the variables are present.

Discussion

From a team performance standpoint, key observations will be focused on the following three hypothesis:

Hypothesis 1: All the students should show improvement in the soft skills growth in the identified categories of the instrument as shown in table 2.

Table 2A: Personal growth in traditional pedagogy.

Number	Growth Category	Personal Growth Pre-Test	Personal Growth Post-Test	Difference
1	Teamwork			
2	Information Gathering			
3	Problem Definition			
4	Idea Generation			
5	Evaluation & Decision Making			
6	Implementation			
7	Communication			

Table 2B: Personal growth in PBL pedagogy.

Number	Growth Category	Personal Growth Pre-Test	Personal Growth Post-Test	Difference
1	Teamwork			
2	Information Gathering			
3	Problem Definition			
4	Idea Generation			
5	Evaluation & Decision Making			
6	Implementation			
7	Communication			

Table 2C: Personal growth for all students in traditional and PBL pedagogy.

Number	Growth Category	Personal Growth Pre-Test	Personal Growth Post-Test	Difference

1	Teamwork			
2	Information Gathering			
3	Problem Definition			
4	Idea Generation			
5	Evaluation & Decision Making			
6	Implementation			
7	Communication			

Hypothesis 2: The class emphasis will be significantly higher in the experimental group of students enrolled in the PBL pedagogy due to the nature of the pedagogy and integration of the curriculum as shown in table 3.

Table 3: Class emphasis comparison between traditional and PBL pedagogy.

Number	Growth Category	Class Emphasis Traditional	Class Emphasis PBL	Difference
1	Teamwork			
2	Information Gathering			
3	Problem Definition			
4	Idea Generation			
5	Evaluation & Decision Making			
6	Implementation			
7	Communication			

Hypothesis 3: Personal growth will be significantly higher in the experimental group of students enrolled in the PBL pedagogy due to the nature of the pedagogy and integration of the curriculum when compared to the students enrolled in the traditional pedagogy as shown below in table

Table 4: Personal growth comparison between traditional and PBL pedagogy.

Number	Growth Category	Class Emphasis Traditional	Class Emphasis PBL	Difference
1	Teamwork			
2	Information Gathering			
3	Problem Definition			
4	Idea Generation			
5	Evaluation & Decision Making			
6	Implementation			
7	Communication			

Hypothesis 4: The mortality of students will be higher in the control group vs the experimental group due to the cohesiveness of the students in the experimental group of students with PBL pedagogy.

Conclusion

The expected conclusions from this study are that the analytical soft skills results in the experimental group of PBL pedagogy will be higher than the control group enrolled in the

traditional learning pedagogy. The difference in results could be attributed to one or combination of the following reasons:

1. In the experimental group, the students work on a project from semester one which is built in the curriculum in teams of four to six students which forces them to work as a team from their first week in college.
2. Six Sigma was built into connections class for the students enrolled in the experimental group which provided them with learnings like teamwork, communications, 5 stages of team, process design, fishbone diagram for analysis, affinity diagram, etc. while they were working on a project. In the control group students might or might not have taken classes on communications, teamwork, etc.
3. In the experimental group, students are enrolled in applied seminar where the students get to learn about their values, goals, individual strengths, etc. for a grade whereas in the control group the student might or might not have attended any applied seminars offered on the main campus.

We would recommend future work on the impact of six sigma in building enhanced analytical soft skills for the both traditional and PBL pedagogy.

References

Bauer-Wolf, J. (2019). Survey: Employers Want 'Soft Skills' From Graduates. Retrieved from https://www.insidehighered.com/quicktakes/2019/01/17/survey-employers-want-soft-skills-graduates.

Casner-Lotto, J., & Barrington, L. (2006). Are They Really Ready to Work? Employers Perspectives on the Basic Knowledge and Applied Skills of New Entrants to the 21st Century U.S. Workforce. Retrieved from: https://www.conference-board.org/pdf_free/BED-06-Workforce.pdf

Caudron, S. (1999). The Hard Case for Soft Skills. *Workforce, 78*(7), 60- 66. Retrieved from:https://www.workforce.com/1999/07/01/the-hard-case-for-soft-skills/

Cline, S. (2005). Soft skills make the difference in the workplace. *Colorado Springs Business Journal.* Retrieved from http://csbj.com/2005/04/01/soft-skills-make-the-difference-in-the-workplace/

Ellis, M., Kisling, E., & Hackworth, R. G. (2014). Teaching Soft Skills Employers Need. *Community College Journal of Research and Practice, 38*(5), 433-453. DOI:10.1080/10668926.2011.567143

Fraenkel, J. R., Hyun, H. H., & Wallen, N. E. (2019). How to design and evaluate research in education (10th ed.). New York, NY: McGraw Hill Education.

Gentili, K., Lyons, J., Davishahl, E., Davis, D., & Beyerlein, S. (2005). *Measuring Added-Value Using a Team Design Skills Growth Survey*. American Society for Engineering Education Annual Conference & Exposition. Portland: American Society for Engineering Education.

Heckman, J. J. & Kautz, T. (2012). Hard evidence on soft skills. *Labour Economics, Elsevier, 19*(4), 451-464. DOI: 10.3386/w18121

Kumar, R. , & Refaei, B. (2017). Problem-Based Learning Pedagogy Fosters Students' Critical Thinking About Writing. *Interdisciplinary Journal of Problem-Based Learning, 11*(2). Available at: https://dx.doi.org/10.7771/1541-5015.1670

Kyllonen, P. C. (2013). Soft Skills for the Workplace. *Change: The Magazine of Higher Learning, 45*(6), 16-23. DOI: 10.1080/00091383.2013.841516

Santicola, L. (2013). Pressing On: Persistence Through A Doctoral Cohort Program in Education. *Contemporary Issues in Education Research,6*(2), 253-264.

Sousa, F. C. (2012). Creativity, Innovation and Collaborative Organizations. *International Journal of Organizational Innovation, 5*(1), 1-39.

Ummah, S. K., In'am, A., & Azmi, R. D. (2019). Creating manipulatives: improving students' creativity through project-based learning. *Journal on Mathematics Education, 10*(1), 93-102.

Woodward, B., Sendall, P., and Ceccucci, W. (2010). Integrating Soft Skill Competencies Through Project-based Learning Across the Information Systems Curriculum. *Information Systems Education Journal, 8* (8). http://isedj.org/8/8/. ISSN: 1545-679X

Wurdinger, S. & Qureshi, M.(2015). Enhancing College Students' Life Skills through Project Based Learning. *Innovative Higher Education, 40*(3), 279-286. DOI:10.1007/s10755-014-9314-3

Wurdinger, S. D., Haar, J., Hugg, B., & Bezon, J. (2007). A qualitative study using project based learning in a mainstream middle school. *Improving Schools, 10*(2), 150–61.

Appendix A – Survey

Class Emphasis			Personal Growth during this Half of the Term	
Major emphasis	**5**		**I experienced a tremendous growth and added many new skills**	**5**
Significant emphasis	**4**		**I experienced a significant growth and added several skills**	**4**
Some emphasis	**3**		**I grew some and gained a few new skills**	**3**
Minor emphasis	**2**		**I used previous skills and had little growth**	**2**
Did not discuss	**1**		**I did not use this skill within this class**	**1**

TEAMWORK	Class Emphasis	Personal Growth
Individuals participate effectively in groups or teams	1 2 3 4 5	1 2 3 4 5
Individuals understand their own and other member's styles of thinking and how they affect teamwork	1 2 3 4 5	1 2 3 4 5
Individuals understand the different roles included in effective teamwork and responsibilities of each role	1 2 3 4 5	1 2 3 4 5
Individuals use effective group communication skills: listening, speaking, visual communication	1 2 3 4 5	1 2 3 4 5
Individuals cooperate to support effective teamwork	1 2 3 4 5	1 2 3 4 5

INFORMATION GATHERING	Class Emphasis	Personal Growth
Individuals gather information, use various sources and techniques, analyze validity and appropriateness	1 2 3 4 5	1 2 3 4 5
Individuals use important visual and oral techniques (questioning, observing) for information gathering	1 2 3 4 5	1 2 3 4 5
Individuals use library resources effectively in accessing relevant information	1 2 3 4 5	1 2 3 4 5

PROBLEM DEFINITION	Class Emphasis	Personal Growth
Individuals define problems, which includes specific goal statement, criteria and constraints	1 2 3 4 5	1 2 3 4 5
Individuals understand the open-ended nature of problems	1 2 3 4 5	1 2 3 4 5
Individuals develop specific goal statements after gathering information about a problem (need)	1 2 3 4 5	1 2 3 4 5
Individuals recognize the importance of problem definition for development of an appropriate design	1 2 3 4 5	1 2 3 4 5
Individuals develop problem definitions with specific criteria and constraints	1 2 3 4 5	1 2 3 4 5

IDEA GENERATION	Class Emphasis	Personal Growth
Teams and individuals utilize effective techniques for idea generation	1 2 3 4 5	1 2 3 4 5
Teams and individuals identify and utilize environments that support idea generation	1 2 3 4 5	1 2 3 4 5
Teams brainstorm effectively	1 2 3 4 5	1 2 3 4 5
Individuals apply effective techniques in their own idea generation	1 2 3 4 5	1 2 3 4 5
Teams use techniques that synthesize ideas to increase overall idea generation	1 2 3 4 5	1 2 3 4 5

EVALUATION AND DECISION MAKING	Class Emphasis	Personal Growth
Teams and individuals utilize critical evaluation and decision making skills and techniques, including testing	1 2 3 4 5	1 2 3 4 5
Teams follow an iterative approach that employs evaluation repeatedly in their design process	1 2 3 4 5	1 2 3 4 5
Teams and individuals apply simple matrix techniques for evaluating proposed solutions	1 2 3 4 5	1 2 3 4 5

IMPLEMENTATION	Class Emphasis	Personal Growth
Teams implement the design to a state of usefulness to prospective clientele	1 2 3 4 5	1 2 3 4 5
Teams manage time and other resources as required to complete their project	1 2 3 4 5	1 2 3 4 5
Team members follow instructions provided by others in implementation	1 2 3 4 5	1 2 3 4 5

COMMUNICATION	Class Emphasis	Personal Growth
Individuals communicate with team members at all stages of development and implementation of design solutions	1 2 3 4 5	1 2 3 4 5
Individuals practice effective listening skills for receiving information accurately	1 2 3 4 5	1 2 3 4 5
Individuals exhibit appropriate nonverbal mannerisms (e.g., eye contact) in interpersonal communication	1 2 3 4 5	1 2 3 4 5
Individuals give and receive constructive criticism and suggestions	1 2 3 4 5	1 2 3 4 5
Individuals record group activities and outcomes, ideas, date, etc. in personal design journals	1 2 3 4 5	1 2 3 4 5
Individuals produce technical papers and memos in acceptable style and format	1 2 3 4 5	1 2 3 4 5
Teams present design information in group oral presentations	1 2 3 4 5	1 2 3 4 5
Individuals communicate geometric relationships using drawings and sketches	1 2 3 4 5	1 2 3 4 5