

Assessing the effect of project based learning on leadership abilities and communication skills

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The accepted methodologies for construction engineering and management education have long recognized that students need to learn a combination of technical and non-technical competencies. Educators then develop their curricula to facilitate learning of these competencies and then assess the students' understanding. For a competency such as cost estimating, these tasks can be accomplished through lectures, take-home problems, and written examinations. However, the development of non-technical competencies such as leadership abilities and communication skills require higher level methods. This paper describes the results of a controlled study that used problem based learning (PBL) to teach these skills and abilities. The results of the experiment were measured using the Competing Value Framework (CVF) developed by Quinn (2004). The results show a statistically significant improvement in the students' ability to set goals, and identify and organize activities to best accomplish those goals. A literature review is included to show why PBL is well suited to teach non-technical competencies as well as technical competencies.

Introduction

The current trend in the construction industry is to build better, faster, and more cost-effectively. Accomplishing this requires the job to be fast-tracked through a team-based approach, such as design-build. This trend requires managers to solve tasks with the assistance of team members, and limitations on time and resources. Due to these challenges, it is critical that organizations employ staff who can work effectively with various types of individuals (Kichuk & Wiesner, 1997). An organization should examine beyond cognitive abilities and look for attributes to enhance team performance. These demands exacerbate the need for construction project managers to have "soft skills" (e.g., communication and stress coping) in addition to "hard skills" (e.g., means and methods of construction).

One of the challenges that organizations face today is the need for qualified employees with positive personality traits. Personality must be carefully considered when accomplishing numerous assignments in various work groups and team performance. Kumar and Hsiao (2007) noted "soft skills" are nontechnical skills such as communication, management, and leadership which are required to be a successful professional.

Despite the known challenges of communications in the construction industry, Thamhain (1992, as cited in Thomas et al., 1998) expressed that few accomplishments have been made. Thamhain identified several critical factors that indicate that interpersonal skills are a critical part of a manager's success. Highly valued managers possess these critical soft skills and use them to make appropriate decisions under real-world conditions. Having a means to assess aptitude in these areas would be a great asset, as it would facilitate better training for current and future project managers. Such an assessment tool would also enable validation of pedagogical methods used to prepare future construction professionals. In order to investigate aptitude in a quantitative format, this study used the CVSS. The CVSS is a tool which has been recognized as providing business related competencies.

Literature Review

Although numerous articles have listed the benefits of problem-based learning, Prince (2004) noted that few data are available which document the effectiveness of this method with undergraduate engineers. Gushgari et al (1997) suggested that further research specifically focusing on the makeup of critical skills would provide insight and advantages to professional development of engineers. Although several have argued that providing professional competencies in graduates would be a monumental challenge, Coll and Zegwaard (2006) concluded these competencies are important.

The current study focused on the use of an active learning hybrid (Problem/Project-Based-PBL) learning method (Prince & Felder, 2006). Prince (2004) conjectured it is not possible to find a universal definition of active learning. According to Bonwell and Eison (1991), active learning is engaging students in problem solving, discussion, reading, and writing to develop higher level thinking skills such as assessment investigation and synthesis. Since active learning has been identified as one of the most positive developments in higher education (McKeachie, 2002), this study investigated whether PBL impacts the outcome of specific “soft skills”: leadership and communication.

Prince and Felder (2006) reviewed the main criteria in problem-based learning. They stressed that problem-based learning begins with providing students open-ended, weakly structured, real world problems. The instructor acts as a facilitator while the students perform a multitude of tasks to complete a final product and/or design. Project-Based Learning generally focuses on developing a finalized product that requires one to use knowledge acquired from previous classes. During this process, students perform significant amounts of investigation and self-directed learning within small groups (Yeo, 2005). During this process the teacher acts as a professional guide, facilitator, or advisor (Ribeiro et al., 2005). The traditional lecture-style learning should be avoided as it is detrimental to the learning styles and thinking skills that are highly valued in the engineering profession (Bernold et al., 2007; Brown, 2004).

Based on this concept, the senior capstone class of the construction managing program at Iowa State University can be described as a small group experience in which students employ active learning using a combination of Problem/Project-Based Learning. Students worked in small groups to solve a multitude of problems and projects in a real-world type environment. They were guided to employ self investigation, acquire resources, and provide solutions in a multi-tasking environment. This style of learning involved a variety of processes requiring a facet of skills including communications (written and oral), decision making, problem solving, time management, planning, and organizing. Traditional lecture-based delivery was rarely used only to help clarify expectations and boundaries.

Assessment Tool Selection

Although there are numerous testing instruments available to measure the skill levels of managers—Meyer Briggs Type Indicator (MBTI), California Personality Inventory (CPI), Fundamental Interpersonal Relations Orientation-Behavior Scale (FIRO-B, etc.— the Competing Values Framework (CVF) model the Competing Value Skill Surveys (CVSS) was chosen to measure the effects of PBL. The purpose for the selection of this tool was to investigate whether soft skills sets would result in a change of behavior of the students who volunteered to participate in the research.

The Competing Value Framework (CVF) model has been recognized as a leading concept in many Master of Business Administration (MBA) programs throughout the world (Quinn 2004). The CVF model has had prior worldwide usage, and the researchers have utilized the CVF’s assessment tool Competing Value Skill Surveys (CVSS) in prior work, it was investigated for use in the current study. Since the business assessment tool provided quantitative data on business related competencies, and the model is associated with Klinger’s (1956) recommendation to include business practices in construction education, it was selected as an applicable tool for this study.

Quinn and Rohrbaugh (1981) noted that organizational effectiveness has received considerable attention in literature, citing 13 sources focusing on this topic. However, despite including this prior research, the authors conceded that a common definition of effectiveness has not emerged and there is lack of agreement by

organizational theorists. The CVF, much like other successful models, is based on prior decades of theoretical views on organizations.

The CVF is a tool that can be used in various organizational contexts. It is able to review management, supervision, leadership roles, and culture, and examine organizational functions and processes, and view gaps. The name “competing value” makes sense due to the CVF’s combination of four different models that are at times in conflict. For example, although most people want organizations with creativity and flexibility, very few would like these attributes at the expense of stability and control. CVF is a concept that enables the visualization of various management theories (i.e., internal process, open systems, rational goal, and human relations). These four competing models fit into quadrants when plotted on two axes. Figure 1 illustrates the CVF as developed by Quinn (2004).

Flexibility appears at top, opposing control at bottom; internal is at left, versus external at right. On further representation, the following framework has four sections with two subsets each, and made of the following as adapted from Quinn (2004):

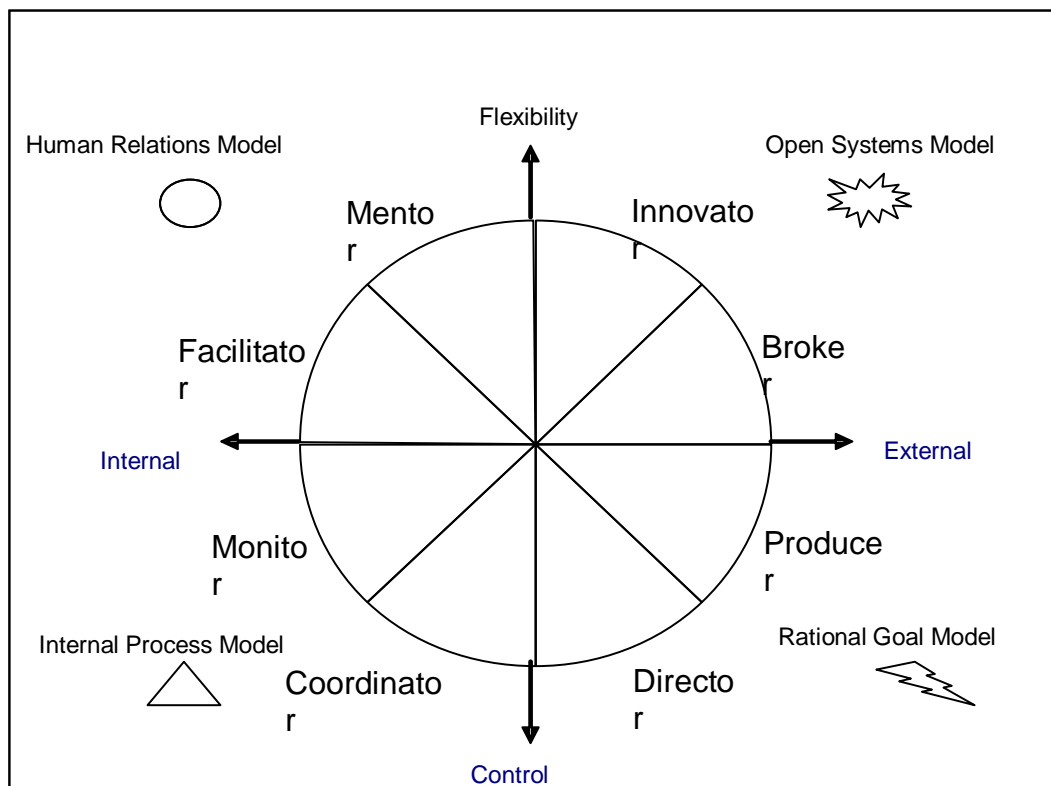


Figure 1. Competing values framework

Hypothesis

In the 1950s, the United States shifted from a practical to theoretical treatment of teaching math and sciences (Roeset & Yao, 2002, Sinha et al., 2002). This shift away from practical to theoretical significantly affected the method in which students were taught. The contents of the curricula paid more attention to theory which was generally taught by the lecture method. Little attention has been paid to sociopolitical, communication, and team working skills (Roeset & Yao 2002). As a result, more graduates are under-equipped to enter the workforce, and need more hands-on training to work effectively in teams (Davies et al., 1999). Educational opportunities that enable open-ended problem solving through successes and failures are the principles for teaching creative behavior (McGraw, 2004). It has been revealed in prior research that appropriate teaching methods can provide an

educational improvement of up to four times (Cohen, 1987). Would active learning such as PBL be such a bridge? Could this method be implemented for all engineering courses? According to Coll and Zegwaard (2006), behavior skills are difficult to develop and measure.

Based on this reasoning, the following hypothesis was proposed to test the impact of PBL methods: PBL will improve leadership abilities and communication skills. Although leadership is difficult to learn in an educational setting (Densten & Gray, 2001) and obtaining gains in effective communication is challenging (Yeo, 2005), researchers have argued that these skills are best taught through the use of PBL (Ribeiro et al., 2005).

According to the Quinn CVF (Quinn 2004), a person who exhibits leadership has the ability to develop vision for a team by setting objectives and organizing the necessary means to obtain the goals. However, an effective leader should not appear too unresponsive to the feelings of others. Instead, the person should balance leadership capabilities with strong communication skills and people skills. Badger (2007) has commented that leadership is directly associated with people and their respective relationships. This view is further supported by the notion that better performers excel in teamwork and collaboration (Caudron, 1999).

As project managers spend more than 70% of their time on communication, the importance of the humanistic side of people should not be discounted. Qualities desired of leaders such as listening, being considerate, and providing opportunities through delegation are typical characteristics. Therefore, in order to be effective, a person must lead with sufficient balance to mentoring and people skills.

Participants and Sample

The participants were undergraduate students in the senior capstone class during the Fall 2005 and Spring 2006 semesters. This single-semester class was designed to use PBL techniques throughout both semesters of the study. This method of delivery employs an intensive team-based exercise that simulates typical experiences of construction industry professionals. This study used a pre-experimental pre-test/post-test design (Creswell, 2003) with the Competing Values Skills Survey (CVSS) which is modeled on the CVF. The researchers also gathered finalized written statements from the participants for the qualitative portion. Furthermore, since this course was a graduating requirement for all students, the students enrolled in the classes were representative of the senior population in the program during the F05 and S06 semesters.

Students attending the class were not informed of the opportunity for participation in the study until the first day of class. When the students were informed, they had the opportunity to decline involvement or complete the necessary agreement to voluntarily participate as a human subject in the research study. Students who chose to become involved and completed the paperwork were provided access to websites and computer codes (as required) to complete the pre-test. They were further informed that, since this was voluntary, they could elect to withdraw at anytime. Since the semester was 16 weeks, and a post-test was required at the end, students were requested to complete their pre-test assessments prior to the end of the first week.

Results

Fall 2005 semester (F05) included 22 students. Of the 22 students available, 15 took the pre-test and 14 took the post-test, for a usable sample size of 14. Spring 2006 semester (S06) had 48 students. Of these 48 students, 42 elected to take the pre-test and 44 the post-test. Combining the two semesters together provides 57 for the pre-test and 58 for the post-test. For the data analysis, only data from students that took both the pre- and post-test were used, giving 14 samples from Fall 2005 and 42 samples from Spring 2006.

The hypothesis appeared to perform statistically strong ($p < .01$) in regard to the summarized correlations. The combined correlations ranged from a low of .348 (understanding others) to a high of .678 (developing and communicating a vision). For the hypothesis testing, tables were provided listing the mean difference (subtracting post-test from the pre-test; a negative indicates an increase), the t value (value used to determine probability), and the 2-tail probability number which related to the t value. Per prior analysis, the key definition probability values of

.05<p≤.10 indicated suggestive; .01<p≤.05 significant; .001<p≤.01 strong; and p≤.001 convincing; were utilized. Subsequent to the analysis of each hypothesis, the final summary section provides a brief overview of the section and results.

Leadership

Table 1 provides a summary of leadership abilities and communication skills with a focus on Leadership. The participants recognized an average increase in all post-test leadership competencies. In this control portion of the framework, in all three competencies, there were statistically significant differences for the paired t tests. In the designing and organizing competency, data indicated strong evidence for F05 (t (13), -3.097, p<.01), additional convincing evidence for S06 (t (43), -4.448, p≤.001), and for F05/S06 combined (t (57), -5.423, p≤.001). The setting goals and objectives competency also indicated statistically significant differences with F05 (t (13), -2.694, p<.05) and S06 (t (43), -2.116, p<.05). A strong statistical difference was indicated for the F05/S06 (t (57), -3.058, p<.01). In respect to the remaining competency, developing and communicating a vision, again statistically significant differences were obtained with F05 (t (13), -2.329, p<.05), strong evidence was determined for S06 (t (43), -2.712, p=.01), and convincing evidence in regards to F05/S06 (t (57), -3.439, p=.001).

Table 1

Leadership abilities and communication skills based on Leadership

Leadership: Director		F05			S06			F05 and S06 Combined		
		Mean Diff.*	T	2-Tail	Mean Diff.*	T	2-Tail	Mean Diff.*	T	2-Tail
Pair 1	Designing and Organizing1; Designing and Organizing	-0.657	-3.097	0.008	-0.559	-4.448	0.000	-0.583	-5.423	0.000
Pair 9	Setting Goals and Objectives1; Setting Goals and Objectives	-0.529	-2.694	0.018	-0.282	-2.116	0.040	-0.341	-3.058	0.003
Pair 17	Developing and Communicating a Vision1; Developing and Communicating a Vision	-0.300	-2.329	0.037	-0.255	-2.712	0.010	-0.266	-3.439	0.001

Designing and Organizing—Determining how best to achieve and accomplish goals and objectives through organization, vision, and strategy, and through dividing them into manageable components.

Setting Goals and Objectives—Identifying what is needed to achieve and accomplish through performance management, reward, prioritized goals, action plans, and management by objective.

Developing and Communicating a Vision—Determining why an organization should exist by seeing the “big picture,” and developing and delivering a vision to life.

*The mean difference was calculated by subtracting post-test from the pre-test; a negative indicates an increase.

Communication

Table 2 provides a summary of leadership abilities and communication skills with a focus on Communication.

Table 2

Leadership abilities and communication skills based on Communication

		F05			S06			F05 and S06 Combined		
		N=14			N=42			N=56		
Communication: Mentor		Mean	<i>T</i>	2-Tail	Mean	<i>T</i>	2-Tail	Mean	<i>T</i>	2-Tail
		Diff.*			Diff.*			Diff.*		
Pair	Developing Employees1; 5 Developing Employees	-0.529	-3.693	0.003	-0.295	-3.053	0.004	-0.352	-4.309	0.000
Pair	Communicating 13 Effectively1; Communicating Effectively	-0.257	-1.618	0.130	-0.191	-2.012	0.051	-0.207	-2.555	0.013
Pair	Understanding Self and 21 Others1; Understanding Self and Others	-0.400	-1.889	0.081	0.073	0.709	0.482	-0.041	-0.431	0.668

Developing Employees—Realizing and implementing delegation through proper responsibility, accountability, authority, and performance evaluations.

Communicating Effectively—Providing positive interpersonal communications through empathetic techniques of reflective listening, discussion analysis, and following rules of effective communication.

Understanding Self and Others—Developing awareness of self-awareness, self-assessment, and self-confidence.

*The mean difference was calculated by subtracting post-test from the pre-test; a negative indicates an increase.

Table 2 displays a flexibility portion of the framework, and the statistical differences of the communication and delegation characteristics of the hypothesis. In this study, all but one (understanding self and others, from S06) indicated an average increase in the post-test associated competencies. Of these three competencies, only one (developing employees) out of three indicated a consistent statistical significance for the data provided. The developing employees competency correlated with strong evidence in F05 ($t(13)$, -3.693 , $p < .01$) and in S06 ($t(43)$, -3.053 , $p < .01$). Convincing statistical difference was discovered for the combined F05/S06 ($t(57)$, -4.309 , $p \leq .001$). Although the communicating effectively competency indicated suggestive statistical difference for S06 ($t(43)$, -2.012 , $p = .051$) and significant difference for F05/S06 ($t(57)$, -2.555 , $p < .05$), it did not provide a significant statistical difference for F05. In respect to the last competency (“understanding self and others”) the data only registered a suggestive statistical difference for F05 ($t(13)$, -1.889 , $p = .081$).

This hypothesis regarding leadership and communication showed that all three competencies for the leadership portion indicated a strong statistical significance for $p < .01$. The combined communication portion lacked statistical significance due to the competency of understanding self and others.

Conclusions

The purpose of this study was to determine if PBL can affect certain soft skills of construction managers. The results of this study suggest that PBL can positively influence several soft skills of the population studied. In addition, the findings of the study suggest that confidence and stress coping, leadership and communication, and adaptability and management skills are all positively influenced. During this process, the results also suggest that students were influenced in a more holistic manner as they were influenced by the real world application that PBL provides. As the advantage of PBL come more to the forefront, more educators can take advantages of its strengths and add to the growing research. Through the collaborative efforts of all concerned entities, great strides in overcoming various perceived obstacles can be made in any type of educational system.

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