Collaborative Learning Methods in Construction Management Education

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Architecture, engineering, and construction industries are advancing in collaborative methods for completing projects. Consequently, educational institutions are investigating methods of teaching students how to effectively function in teams to prepare students for industry. Most of the proposed methods are resource intensive and require extensive planning before students are introduced to the teamwork training. This paper presents results of an exploratory investigation into applying a current training method as a one-time intervention. The goal of the research was to identify if this method of training will impact student’s attitudes and behaviors about teamwork. A two phase, survey based research project collected data from civil engineering technology and construction management students at the University of North Carolina at Charlotte. The resulting data highlighted a significant change in attitudes between phases for 18 survey items. 44% of the significant responses were associated with communication. The results suggest that future studies for teamwork trainings with limited resources focus on communication for the highest chances of positive outcomes in a short period of time.

**Key Words:** construction education, teamwork, TEACH framework, collaborative education

**Introduction**

As architecture, engineering and construction (AEC) industries move toward more collaborative approaches for delivering projects, educational practices have started to reflect this shift (Becerik-Gerber and Kensek, 2010). Educators seek to foster an environment conducive to collaborative learning while also preparing students for industry practice (Becerik-Gerber and Kensek, 2010). However, in industries long focused on individual success, shifting to a team environment evolves slowly. An obstacle of educators is overcoming internal difficulties associated with teamwork, such as negative attitudes, to implement more collaborative approaches of practice and learning (Becerik-Gerber and Forgues, 2013).

A common method to overcoming these obstacles is the incorporation of collaborative learning environments. However, many present collaborative learning environments for students remain focused on teaching technical skills (Seat et al., 2001). The singular measure of performance is the end result of completing a group project. In engineering education, Seat et al. (2001) research challenged the traditional methods of technical based collaborative learning. The research introduced an academic minor program focused on performance skills such as interpersonal skills, communication skills, and teaming skills. The importance of engineering students’ performance skills was researched in addition to technical skills to develop a more comprehensive collaborative environment. This environment examined the process and skills conducive to collaboration and comprehensive professional development for students.

As an approach to collaborative learning, the methodology developed a system of teaching collaboration and the skills identified for effective collaboration. However, replication to other higher educations would be difficult because the protocol is both time and resource intensive. This paper presents results of an exploratory research study to investigate the practical education problem of the current time and resource intensive nature of teamwork training for construction students. The purpose of this research was to identify areas of focus for teaching teamwork skills, based on a peer reviewed training framework, which can be taught concurrently with class curriculum. Research objectives included not only investigating the introduction of an abridged teamwork training program but also completing the process with minimum available time and resources. The research focused on building students’

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awareness of teamwork skills and measuring students’ perceptions of those skills to identify skills most impacted. The research did not focus on building technical skills or the end result of a project.

Literature Review

The researchers examined a recently developed, scientific team training program: TEACH Teamwork.

APA TEACH Teamwork

Analysis of team performance is a major research topic across disciplines. Salas, Sims and Burke (2005) condensed their research findings of team functions, and the drivers, into the Big 5 components of team performance. These five components are leadership, mutual performance monitoring, backup behavior, adaptability, and team orientation (Salas et al., 2005). Team Strategies and Tolls to Enhance Performance and Patient Safety (TeamSTEPPS) introduced the concept of the Big 5 to healthcare team training. The TeamSTEPPS program, created by the Agency for Healthcare Research and Quality and the Department of Defense’s Patient Safety program, is a program tailored to teaching healthcare students and professionals how to function as effective teams (King et al., 2008). The current program is a multifaceted approach to team training and assessment. In addition to teaching teamwork, the program highlights areas of improvement for teams and provides instructors with the tools to improve performance. TeamSTEPPS synthesized the Big 5 into four applications of teamwork concentration to include communication, situation monitoring, mutual support, and leadership (King et al., 2008).

The American Psychological Association’s TEACH Teamwork training framework is a derivative of the TeamSTEPPS program. TEACH’s goal is to apply a science-based approach to teaching teamwork in a school setting geared specifically to faculty (Benishek et al., 2016). The program follows the core teamwork principles outlined by Salas, Sims, and Burke (2005) and applied in TeamSTEPPS. Each module is related to a Big 5 skill. For the purpose of this research, Conflict Resolution was analyzed separately. TEACH Teamwork defines these skills in the learning modules as the following (Benishek et al., 2016):

- **Communication**: the creation of dialogue between two or more individuals for shared perspective, information exchange, and talent integration
- **Situation Monitoring**: the scanning of the environment to seek out important information including monitoring teammates and progress towards goals
- **Conflict Resolution**: applying support techniques to resolve tension and disagreements that delay the achievement of team goals and productivity
- **Mutual Support**: the back-up behavior given to one or more team members as needed for the benefit of an individual or the greater good of the team
- **Leadership**: carrying out necessary behaviors in order to help the team accomplish their goals

The TEACH Teamwork framework developed from interview feedback and further research of effective teaching techniques. The resulting curriculum includes didactic information, self-reflection questions, videos-based demonstrations, and various applied activities (Benishek et al., 2016). TEACH Teamwork’s training modules emphasize these principles as the skills necessary to creating more effective teams.

The training modules have been tested and published for public use. The entire program and supplemental materials are available, for free, online. This aligns with the goals of the researchers to have the training available to the end-user in a manner that is more easily integrated for the needs of the school (Benishek et al., 2016). Unlike other teamwork training programs, this program was not sponsored by a major grant. Therefore, follow up of implementation of the training tools is not as widely documented. However, the same rigor of literature review, research, and testing has been applied by educators, psychologists, and professionals contributing to the project (Benishek et al., 2016).
Research Objective

The goal of this exploratory study was to assess how the TEACH framework would impact student awareness of team teamwork in group projects. Specifically, this study was designed to address the following research questions:

RQ 1: Can a one-time teamwork training intervention impact student’s attitudes and behaviors about teamwork?

RQ 2: What are the skills most impacted by a one-time teamwork training intervention?

The objective of RQ 1 was to measure if focusing on time as a constraint would still allow students awareness to change from the introduction of TEACH Teamwork. The objective of RQ 2 was to identify what skills still showed a changed in awareness with time as a constraint. Those skills would be recommended for further research.

Methodology

Teamwork Training Selection

TEACH Teamwork training modules were selected for the adaptability to two conditions. The first condition was the accessibility of the program. This reflected the end goal of an accessible training program that can be adopted by educators with minimal resources. The PowerPoint format of the training, in addition to a provided script for each module, allows for easy integration into the classroom (Benishek et al., 2016). Online availability of the training modules gives instructors easy access to TEACH Teamwork. The second condition was the ability of the training to be integrated into a regular class time to eliminate the need for extra sessions. TEACH Teamwork was adaptable to a class setting in the form of PowerPoint presentations.

Teamwork Training Assessments

The TEACH Teamwork modules did not include an assessment protocol, therefore three peer-reviewed assessments were selected that focused on the major skills addressed by the TEACH Teamwork modules. The three selected assessments were CII Compass, CATME SMARTER Teamwork and TeamSTEPPS PACT-Novice. CATME assessment tool focused on five categories of individual behavior in the team: contributing to the team’s work, interacting with teammates, keeping the team on track, expecting quality and having relevant knowledge, skills and abilities (Loughry et al., 2007). The PACT-Novice observer tool was designed to help measure the effectiveness of received interprofessional training in the medical field (Chiu et al., 2013). Validated questions from Brock et al. (2011a) and Brock et al. (2011b) Pre/Post Assessment in TeamSTEPPS PACT-Novice was used. The CII Compass tool was designed to highlight areas of strength and weakness thus allowing the users to understand the communication needs of the team based on six identified critical communications issues of accuracy, timeliness, completeness, understanding, barriers, and procedures (Compass, 2011). These three assessments were chosen for their accessibility, adaptability to survey format for integration into classroom, and relevance to TEACH Teamwork training modules. All selected assessments were from peer reviewed research.

A three-part survey integrated the three selected assessments into the research methodology. Questions from the assessments parallel the themes and assessment tools embedded within the TEACH Teamwork training modules. The first survey (“pre-survey”) assessed students’ attitudes about group work before the completion of a group project. The second survey (“during-survey”) assessed students’ attitudes and perceived performance of the team using the Big 5 related teamwork skills, and was conducted about halfway through completion of the students’ group project. The third survey (“post-survey”) assessed students’ attitudes and perceived performance of the team after the group project was completed. All three surveys consisted of a total of 114 questions. Students were not required to take the surveys as part of the class curriculum. All questions in the surveys were optional, and students could opt out at any time during the surveys’ completion. The Qualtrics survey platform was used to distribute an anonymous link to students (to prevent individual identification) and collect results.

This research study was modelled after the Pre/Post format of the selected assessments. Pre/Post was retitled Phase1/Phase2. Phase 1 was completed before the teamwork training intervention. Phase 2 was completed after the
teamwork training intervention. This research study was approved by the Institutional Review Board for Research under IRB Number 16-0985.

**Inclusion Criteria and Recruitment**

Students enrolled in the undergraduate civil engineering technology and construction management courses at UNC Charlotte were eligible to participate in this research. The inclusion criteria for class curriculum selection included the following:

- Class curriculum related to construction field.
- Must have at least two group projects during the duration of the research study.
- In-class time available for TEACH Teamwork training modules.

Three classes met the inclusion criteria: Cost Estimating, Capstone, and Construction Mean and Methods. Students recruited from these classes were a mixture of male and female, sophomores, juniors and seniors. Participation in the research study was optional and not a requirement of the class. In-class recruitment was completed at the beginning of the semester for each class. This included an overview of the research study, risks, and informed consent.

**Research Execution**

**PHASE ONE:** At the beginning of the semester, the faculty assigned students groups using random team assignment in Excel. Before the first group project was assigned, students completed the Phase One Pre-Survey. After the teacher assigned the first group project, students completed the Phase One During-Survey. Once the group project was completed, students completed the Phase One Post-Survey. These Phase One surveys, three in total, were completed before the introduction of the TEACH Teamwork training modules.

**TRAINING INTERVENTION:** The TEACH Teamwork Training Module PowerPoints were recorded into video lectures. The lectures followed the instructor script included from TEACH Teamwork (2016). Each module consisted of 1-3 videos. The training videos were shown during one normal class meeting time. The video playlist and original PowerPoint presentation (in addition to the instructor script) were available to students for reference online after the training class.

**PHASE TWO:** After students completed the TEACH Teamwork training, the process of Phase Two was completed. The survey questions were repeated from Phase One for all three surveys. Before the second group project was assigned, students completed the Phase Two Pre-Survey. After the teacher assigned the second group project, students completed the Phase Two During-Survey. Once the second group project was completed, students completed the Phase Two Post-Survey. These Phase Two surveys, three in total, are completed after the introduction of the TEACH Teamwork training modules. The results of the surveys from Phase One were compared to the results of Phase Two.

**Data Results and Analysis**

The anonymous responses produced unpaired, non-parametric, and non-normally distributed data. Therefore, the Mann-Whitney U test for independent samples was used to assess the difference in survey responses between Phase 1 and Phase 2 (that is, Pre and Post the intervention) (Daniel, 1990). The Mann-Whitney U test compares the shift of the distributions by comparing the medians between the two groups. Four assumptions were met to ensure the data fit requirements for use of the Mann-Whitney U test:

- The dependent variable (responses to the TEACH framework survey questions) was measured on an ordinal scale in the form of Likert data.
- The independent data, Phase 1 and Phase 2, were categorical and independent groups.
- Phase 1 and Phase 2 were unpaired observations due to the anonymity of the surveys.
- The distribution was not normally distributed because of the ordinal nature of the data.
While additional data that is closer to a normal distribution combined with that of a control group is preferred, the researchers were seeking to identify steps for further research development, and not necessarily firm conclusions (Common Guidelines for Education Research and Development, 2013). The Mann-Whitney U test was performed for all 114 questions to compare the Phase 1 results to the Phase 2 results. The confidence level was set at 90%, $\alpha = 0.1$. A 90% confidence level allows the significant changes to be noted without disregarding potential impacts that fall out of the standard 95%, $\alpha = 0.05$. The questions with a $p$-value of less than 0.1 were selected for additional analysis. Statistical analysis was conducted using IBM Statistical Package for Social Sciences, version 23.

Analysis

A total 87 students were eligible to complete the Phase 1 surveys. An average of 72 responses were collected for all three surveys of Phase 1. This yielded an 83% response rate. The average academic standing for students was 9% sophomore, 35% junior and 56% senior. 88% of the students completing the survey and demographic data were Male. A mean of 80% of students reported having professional experience related to their field of study. A mean of 57% students were currently working in the profession related to their field of study. Most students were not involved in extracurricular activities.

While 87 students were eligible to complete the Phase 2 surveys, only about 30 responses were collected for all three surveys of Phase 2 (34% response rate). The smaller response rate in Phase 2 could not be contributed to a specific cause. Phase 1 could not be paired to Phase 2, by students or class, because the surveys were anonymous. Also, possible outside influences, such as midterm evaluations, may have affected the response rate. However, the influence of outside influences cannot be established in the absence of a control group. The average academic standing for students were 19% junior and 81% senior. 90% of the students completing the survey and demographic data were Male. The average credit hours taken this semester for students completing these surveys was 15 credit hours. A mean of 83% of students reported having professional experience related to their field and study. A mean of 50% students were currently working in the profession related to their field of study. A total of 18 items, displayed in Table 1, were statistically significant. The results suggest these areas were impacted by the one-time training intervention.

Table 1

**Student Evaluation of Various Teamwork Attributes after Teaching Intervention**

<table>
<thead>
<tr>
<th>Student Responses</th>
<th>Mann Whitney U</th>
<th>Asymp. Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-survey</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is difficult to TRAIN individuals how to be better communicators.</td>
<td>792.00</td>
<td>0.030</td>
</tr>
<tr>
<td>Teams that DO NOT communicate effectively significantly INCREASE THEIR RISK of committing errors.</td>
<td>869.50</td>
<td>0.081</td>
</tr>
<tr>
<td>I am able to RESOLVE conflicts between individuals effectively.</td>
<td>867.00</td>
<td>0.089</td>
</tr>
<tr>
<td>Team leaders should ENSURE that team members HELP EACH OTHER out when necessary.</td>
<td>882.00</td>
<td>0.108</td>
</tr>
<tr>
<td><strong>During-survey</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How often do you receive LESS INFORMATION than you need?</td>
<td>652.00</td>
<td>0.009</td>
</tr>
<tr>
<td>How often does POOR COMMUNICATION or LACK OF COORDINATION occur in your project?</td>
<td>681.0</td>
<td>0.018</td>
</tr>
<tr>
<td>They IDENTIFY goals, ASSIGN roles and responsibilities, HOLD members ACCOUNTABLE.</td>
<td>746.50</td>
<td>0.051</td>
</tr>
<tr>
<td>How often do you receive CONFLICTING INFORMATION from more than one person?</td>
<td>735.00</td>
<td>0.056</td>
</tr>
<tr>
<td><strong>Post-survey</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I BELIEVED that the team should achieve high standards.</td>
<td>882.00</td>
<td>0.026</td>
</tr>
<tr>
<td>They let other TEAM MEMBERS HELP when it was necessary.</td>
<td>871.00</td>
<td>0.026</td>
</tr>
<tr>
<td>They kept TRYING when faced with difficult situations.</td>
<td>894.50</td>
<td>0.036</td>
</tr>
<tr>
<td>I provided CONSTRUCTIVE FEEDBACK to others on the team.</td>
<td>895.00</td>
<td>0.048</td>
</tr>
</tbody>
</table>
They had enough KNOWLEDGE of teammates’ jobs to be able to FILL IN IF NECESSARY. 928.50 0.080
They ACCEPTED FEEDBACK about strengths and weaknesses from teammates. 934.00 0.085
I FULFILLED RESPONSIBILITIES to the team. 942.00 0.088
They EXCHANGED INFORMATION with teammates in a TIMELY manner. 935.00 0.088
I EXCHANGED INFORMATION with teammates in a TIMELY manner. 941.00 0.096
I CARED that the team produced high-quality work. 961.00 0.100

Discussion

Comparison of means analysis revealed 15 of the 18 significant items showed a negative change in attitudes and behaviors from Phase 1 to Phase 2. This negative change in attitudes and behaviors does not conclusively indicate the training was not successful, however. While the researchers are unable to conclusively identify the cause of this negative change after the intervention, one potential explanation is that students were made more aware of optimal team practices, and were frustrated when they did not observe this in their own teams. This potential explanation is somewhat supported by the data shown in Table 2, which shows the appropriate Big 5 related Teamwork Skills category for each of the TEACH framework attributes. Communication skills had the most frequent occurrence of significant questions accounting for 44% of the 18 statistically significant TEACH assessments.

Table 2

Statistically Significant TEACH Assessments Grouped by Big 5 Related Skills

<table>
<thead>
<tr>
<th>Question</th>
<th>Big 5 Related Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>How often do you receive LESS INFORMATION than you need?</td>
<td>Communication</td>
</tr>
<tr>
<td>How often does POOR COMMUNICATION or LACK OF COORDINATION occur in your project?</td>
<td>Communication</td>
</tr>
<tr>
<td>It is difficult to train individuals how to be better communicators.</td>
<td>Communication</td>
</tr>
<tr>
<td>I provided CONSTRUCTIVE FEEDBACK to others on the team.</td>
<td>Communication</td>
</tr>
<tr>
<td>How often do you receive CONFLICTING INFORMATION from more than one person?</td>
<td>Communication</td>
</tr>
<tr>
<td>Teams that do not communicate effectively, significantly increase their risk of committing errors.</td>
<td>Communication</td>
</tr>
<tr>
<td>They EXCHANGED INFORMATION with teammates in a TIMELY manner.</td>
<td>Communication</td>
</tr>
<tr>
<td>I EXCHANGED INFORMATION with teammates in a TIMELY manner.</td>
<td>Communication</td>
</tr>
<tr>
<td>They kept TRYING when faced with difficult situations.</td>
<td>Conflict Resolution</td>
</tr>
<tr>
<td>They ACCEPTED FEEDBACK about strengths and weaknesses from teammates.</td>
<td>Conflict Resolution</td>
</tr>
<tr>
<td>I am able to resolve conflicts between individuals effectively.</td>
<td>Conflict Resolution</td>
</tr>
<tr>
<td>They had enough KNOWLEDGE of teammates’ jobs to FILL IN IF NECESSARY.</td>
<td>Leadership</td>
</tr>
<tr>
<td>Team leaders should ensure that team members help each other out when necessary.</td>
<td>Leadership</td>
</tr>
<tr>
<td>I BELIEVED that the team should achieve high standards.</td>
<td>Mutual Support</td>
</tr>
<tr>
<td>I FULFILLED RESPONSIBILITIES to the team.</td>
<td>Mutual Support</td>
</tr>
<tr>
<td>I CARED that the team produced high-quality work.</td>
<td>Mutual Support</td>
</tr>
<tr>
<td>They let other TEAM MEMBERS HELP when it was necessary.</td>
<td>Situation Monitoring</td>
</tr>
<tr>
<td>They IDENTIFY goals, ASSIGN roles and responsibilities, HOLD members ACCOUNTABLE</td>
<td>Situation Monitoring</td>
</tr>
</tbody>
</table>

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Based on descriptive and statistical analysis of the Phase 1 and Phase 2 surveys, the following conclusions have been determined in relation to the research questions:

**RQ 1:** *Can a one-time teamwork training intervention impact student’s attitudes and behaviors about teamwork?* Changes were noted in the data from Phase 1 to Phase 2. The differences are based in a correlation and not a causation due to the type of data collected. It can be inferred that the teamwork training informed students on what attitudes and behaviors should be present in an effective team. Therefore, the change between Phase 1 and Phase 2 may be attributed to increased awareness.

**RQ 2:** *What are the skills most impacted by a one-time teamwork training intervention?* All skills noted significant changes. However, communication was the skill most frequently observed in statistically significant questions. This is meaningful as communication is an integral aspect of applying the other four skills. Communication is required to resolve conflicts, provide leaderships to others, provide support and deliver updates about situations affecting the team. Addressing communication as the focus of a teamwork training provides a foundation to build upon for the other four skills.

**Conclusion and Future Research**

This research study demonstrated how a teamwork training intervention, albeit small in scope, has the potential to impact major teamwork skills. It introduced examples of how teams can effectively function, allowing students to compare performance skills instead of results based on technical skills. This is a beginning step to addresses the major obstacle of overcoming negative attitudes, as stated by Beccerik-Gerber and Forgues (2013), because it introduces positive examples of effective teamwork. Students are able to observe this performance skills in their own groups. Small scope interventions, such as this research study, may better prepare students for more in-depth teamwork training because it established the foundation of what teamwork is, why it is important and how it can impact not only the project outcomes but also the group members. Therefore, early introduction of small scope interventions, such as the beginning semesters, would provide a foundation and time to further develop skills. Students’ understanding could be tested with more complex group projects reflecting common situations encountered in industries. The small scope interventions could then act as a refresher or reference for students.

Although these results provide feedback directly beneficial to the development of construction students, the results and recommendations are not exclusive to the future construction professionals. As the shift continues to collaborative approaches to business and project delivery in the AEC industry, the three disciplines will need the same performance to advance teams together. Thus, higher education may help by providing the foundation for future working relationships.

Further research is recommended to investigate the effectiveness of communication instruction in a classroom training intervention. In testing a framework that can be integrated quickly into a class setting and with little resources, communication has been shown to be the most impacted skill in a short amount of time. Situation monitoring was the second skill most impacted by a classroom training intervention and is also recommended for further research. Additional incorporation of paired assessments, including a control group, would allow more rigorous testing of the effectiveness of the training tool and ability to establish concrete conclusions. Additional research in the use of facilitation methods, in conjunction with the training intervention, would potentially help to reinforce the effectiveness of the training tool as noted by professors and students. Teaching the modules in parts, instead of one continuous lesson, may also help students to better understand concepts. Overall, the continuous research of team training for AEC students is beneficial to the development of student’s skillsets not only for the higher education but also industry.
References


