

# Teaching Interdisciplinary Collaboration in Undergraduate Foundation Level Courses

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When students graduate from their respective programs related to the building industry they are expected to be able to work in interdisciplinary teams. They must have a basic level of understanding of the related disciplines they are working with as well as the ability to communicate ideas in a way that are sensible to the goals of the project and each individual member of the team. To support this development of understanding collaborative efforts, foundation level introductory classes from construction management and architecture used two teaching strategies: 1.) joint classroom sessions and 2.) an interdisciplinary team project. The classroom sessions were organized around demonstrating examples of higher-level collaboration of project teams. The interdisciplinary group project was supported with additional coaching within their respective classes. The project involved a submission for the schematic design and construction plan of a small project as well as reflections on the collaborative process used by the team. This paper discusses the two strategies, classroom outcomes, feedback from students, and faculty observations to the successes and challenges through the process.

**Keywords:** Undergraduate, Education, Collaboration, Interdisciplinary, Teamwork

## Introduction

Preparing students for the future collaborative workplace is essential and must be a priority alongside specific skills of each building discipline. With the current industry shift from Design/Bid/Build to more collaborative project delivery approaches like Design/Build, Construction Manager at Risk (CM/R), and Integrated Project Delivery (IPD), many future professionals need to be skilled in collaborative practices. Two strategies for introducing interdisciplinary collaboration at Clemson University have been explored. The first technique used in teaching collaboration was the involvement of professional, interdisciplinary teams in foundation level university courses. These professional teams communicated the importance of collaboration in contemporary practice. The interaction with professionals not only explained collaborative team approaches to design and construction in the profession but also modeled collaboration to the class in their presentation. The second technique required students from the Architecture and Construction Science and Management introductory courses to participate on a collaborative project. This paper discusses the two techniques, explains the outcomes of those techniques, and elaborates on the lessons learned through the process.

## Supporting Literature for Pedagogical Methods

Successful collaboration is a learned skill (Salas, Sims, and Burke, 2005). Additionally, teamwork and collaboration are important variables young design and construction professionals need to be prepared for to ensure a successful project (Olatunji and Akanmu, 2014). Mazzetto (2018) found that multidisciplinary collaboration can provide a unique learning experience to develop students' managerial skills. While Penttila and Elger (2006) recognized that a

diverse multidisciplinary understanding and knowledge about design and construction is essential for professionals in the built environment.

Simply dividing students into equal groups to complete a project can lead to a shortfall of team success when definitions of what constitutes a successful or failed team are left up to the students to identify. These factors of successful collaboration must be taught. The educators used two texts to inform the teaching and assessment of these skills. One of the texts covers the necessary skills to work effectively in a team (Salas, Sims, and Burke, 2005). The second text informs the assessment of teams and the individuals involved in the collaborative project (Kennery & Stickney, 2013).

Salas, Sims, and Burke (2005) states that team effectiveness goes far beyond a simple project and must take a more holistic perspective that includes how a team interacts to achieve the desired outcome by identifying five essential elements for team success: effective team leadership, supportive mutual performance monitoring, backup behavior, adaptability, and team orientation. Additionally, three supporting mechanisms for ensuring team success are defined (Salas, Sims, and Burke, 2005):

1. Shared mental model – a common outcome that a team can share as their primary goals
2. Mutual trust – a shared agreement that team members will perform their tasks to benefit the group
3. Closed-loop communications – communications that are sent are acknowledged as received and understood

Introducing these elements and mechanisms early in a student's education can impact how they approach and conduct collaborative projects throughout their education and into their professions. These are skills and techniques that students should practice and employ in order to hone their skills (Salas, Sims, and Burke, 2005). These skills and techniques were incorporated into the interdisciplinary group project discussed below.

Beyond elements of successful team interactions, the team-related performance must also be measured. Kennery & Stickney (2013) offer measures at both the team and individual level to measure team performance. Individual can be assessed based on behavior (how well participants work with other team members) and results (the products that the person contributed to the team). Team level performance can be measured by team's processes (where a team is assessed on its internal group dynamics) and by the team's results (measuring the work results and products). Team processes address how well the team works together as a group, the effectiveness of team meetings, the ability of the team to reach consensus, and the team's problem-solving techniques. Measures of team's results could include: the completeness of the project; the use, acceptance, and understandability of the team's final deliverables; the number of customer requests for the team's report; the subscription rate of the team's newsletter. These four assessment measures and methods were used when developing rubrics and reflection prompts in order to encourage the students to understand the complex nature of assessing teamwork. It is necessary to assess teamwork using all four of these criteria to understand where the performance can be improved.

### **Interdisciplinary Class Setup**

Two foundation level courses, CSM 1000 Introduction to Construction Science and Management and ARCH 1010 Introduction to Architecture, are taught by their respective departments as independent courses. Faculty from both departments have identified the importance for cross-disciplinary exposure of students in both programs. This exposure is required to adequately prepare the students for collaborative project delivery methods that they will encounter in the industry. The two courses were scheduled with a common time on Fridays to allow for joint sessions of both classes. Goals for these joint sessions were targeted at identifying the importance of collaboration, demonstrating methods of collaboration between industry professionals, and allowing students to collaborate in interdisciplinary teams on a project.

The joint classroom sessions were scheduled for four times throughout the semester. The first was to bring in administration from each department involved, including landscape architecture as a third collaborator, to discuss how they collaborated within the university and how they viewed collaboration within the industry. The second joint session involved a project team working on a capital project on campus (Figure 1). The team presented the project and discussed how collaboration, teamwork, and trust were necessary to meet intense scheduling and budget demands. The project team was able to identify specific instances within the project when they had to rely on another team member to meet common project goals. The third session included introducing the collaborative project goals, project description, and allowing project teams time to work and collaborate. The last session included a project debrief after the projects were submitted and evaluated. The debrief consisted of faculty providing feedback on “best of” categories of proposals and allowed for discussion with the students about the project.



*Figure 1:* Industry project team presentation to joint session of classes.

### **Collaborative Project Description**

The students from the two classes were placed in teams of 6 students to complete an interdisciplinary project. Due to the nature of the two programs, the introductory course for architecture was larger so there were more architecture students per team than construction management students. The students were randomly assigned by the faculty of the course.

The students were tasked with designing and planning the construction of a dog house within a \$500 budget and a defined schedule of three weeks allocated for design and construction. As part of the project description the teams were provided with some information from the family, the type of dog that would be using the house, and a site layout of the property. Submissions were to include: the design conceptual statement, the conceptual design drawings (Figure 2), a schedule for the project, and an estimate of materials, labor, and equipment (Figure 3). The teams also had to include a collaboration plan. The collaboration plan used the elements and mechanisms described in Salas, Sims, and Burke (2005) as a starting point. The collaboration plan included a leadership plan, common goals, open communication plan, conflict resolution strategy, and a description of implemented trust building techniques.

The main objective for the project was to require the students to think about how they can work together and plan for a team driven project. This was done through the creation of the collaboration plan, working together during the project, and reflecting the team’s processes and end product. The reflections were collected from each team member as well as a summary reflection from each group. Specifics of how the team defined leadership roles, set up communication strategies, built trust, and resolved conflict were part of the collaboration plans and reflections.

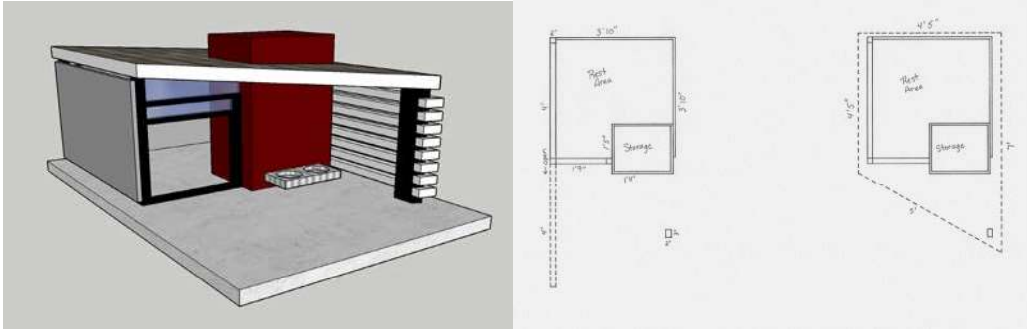


Figure 2: Sample student project design of collaborative doghouse project.

Work Breakdown Structure	Amount	Material Unit Cost	Total
Sitework			
Foundation			
pavers	40	1.58	63.2
Framing			
Walls			
2 x 4 frames	10	3.27	32.7
2 x 2 frames	1	1.98	1.98
track for sliding door	2	11.94	23.88
plywood	3	34.99	104.97
Roof			
shingles	1	26	26
hinges	2	2.78	5.56
Finishing			
Paint			
black	1	9.78	9.78
red	1	8.47	8.47
white	1	9.78	9.78
dog bowls	2	3	6
shelving bracket	2	5.97	11.94
		Labor	120
		Overhead	50
		Profit	26
		<b>Total</b>	<b>\$500</b>

Figure 3: Sample student estimate for project.

During the third joint session, the project was introduced with time for general questions. The students were then provided time to meet in their assigned groups. The students were asked to set a meeting time to go into more depth on the project within the next few days to start the project. Project teams were asked to define specific milestones and have meetings set to discuss those milestones and make appropriate decisions. Additional classroom time was used to guide the students through phases of the project but was not used as a time for project teams to complete the work. For example, during the ARCH 1010 class, time was given to identifying what types of information should be included in a conceptual plan drawing that would allow someone who is building it to properly estimate material quantities. For the CSM 1000 course, basics of estimating and how to tally up pieces and apply costs were discussed with basic concepts of sequencing a schedule. Because it was an introductory course, the design detail, schedule, and estimate were fairly schematic. The importance of the group project was to serve as a vehicle for the students to experience collaboration.

Upon completion, the project was then evaluated by the faculty for completeness in addressing the project description. This included reviewing the collaboration plan and reflections. The students also completed peer and self-evaluations of each team members attributes in contributing to the project. The peer and self-evaluation

accounted for 50% of the overall individual grade for the project. The attributes for the assessment included dependability, responsibility/accountability, quality of work provided, respect, courage, consideration, and communication. Additionally each student was required to provide a one page reflection of the process and how they viewed the collaboration among the team, what they learned about a collaborative process and the other domain, and what they would do again or do differently if they were confronted with an interdisciplinary, collaborative project.

## Course Outcomes

The project's learning impact was assessed using surveys, written reflections, and observations. All students were asked to complete a survey at the completion of the course to provide feedback. Additionally, students completed two reflections over the course of the semester, one after the interdisciplinary team presented in class and the second after the completion of the collaborative project. Finally, faculty observations are also included as to how the collaborative classroom experiences affected the participating students.

### *Surveys*

The surveys show in each response that the collaboration aspects of the class impacted the students' view of the building discipline in a positive way. They were asked to respond to both strategies: the joint classes where the professional team presented and the collaborative project.

The responses referring to the joint class presentation of the professional multidisciplinary team had the following results.

- 50% of students answered "Very Much" when responding to the statement: "the professional design and construction team presentation was valuable to their learning." And another 36.36% thought it was valuable.
- 40.91% answered "Very Much" when asked, "to what extent did the presentation by the team influence and inform your own collaborative project?" And, 29.55% said it affected them.
- 40.91% answered "Very Much" when asked, "to what extent did the presentation by the team help you appreciate other professions in the building industry?" While, 36.36% said it helped.
- 34.09% answered "Very Much" when asked, "to what extent do you think the presentation by the team will help you in your future professional career?" And, 36.36% said it helped.

These responses are reassuring and affirm the importance of including professionals in the classroom in order to model successful collaboration in practice.

The collaborative project employed in the course had similar results:

- 40.48% answered "Very Much" when asked, "was the collaborative dog house project valuable to your learning?" And, 30.95 said it was valuable.
- 40.48% answered "Very Much" when asked, "to what extent did the collaborative dog house project help you appreciate other professions in the building industry?" And 26.19% said it helped.
- 19.05% answered "Very Much" when asked, "to what extent do you think the collaborative dog house project will help you in your future professional career?" And, 45.24% said it helped.

The results from the surveys indicate that it is valuable to begin educating our students on collaboration even in the very first semester of college. The results from the projects make it obvious that while our students are not proficient at team work, it is helpful and valuable to start developing these skills early.

### *Reflections*

Students were required to submit reflections after both teaching techniques. After the interdisciplinary project team presentation, the students expressed interest and appreciation of how various domains could participate on a project in a collaborative way. Many students admitted that prior to the class they did not see the domains of architecture and construction as being collaborative. Keeping in mind this is during the first semester of their academic programs, some acknowledged preconceived notions of the architect and construction professional being adversarial in ways where the architect just “wants something to look good” and the construction professional always “cutting something out to meet a budget”. The collaborative approach modeled by the industry professionals helped remove these preconceptions of professionals working in their individual silos and helped students see beyond the traditional methods of a Design-Bid-Build project delivery.

The written reflections for the interdisciplinary project show the struggles that are part of any collaborative project. But, even when the team work was difficult, students overwhelmingly understood the benefit and were hopeful about the future of working in teams in the professional world. Some common themes from the student reflections on the skills developed throughout the project are summarized as:

- Teamwork:
  - “All of us working towards a common goal is what kept me motivated and I believe it did the same for my team members as well. We all cared for our design to be efficient, affordable, and stylish. Which is why I believed each member was a leader in a specific way that help contribute to the final design”
  - “I learned that everyone has different strengths to bring to the table, and allowing people to voice that and contribute that to the group is very important.”
- Time Management:
  - “Although we have worked on the skill of time management throughout this course, every deadline has been for an individual project and I was able to complete the work on my own schedule. In contrast, completing tasks for this project put a greater amount of responsibility in my hands, because my teammates were relying on me to complete tasks.”
  - “I learned that it’s much better to front load a schedule because something may set you back later down the line.”
- Leadership:
  - “Although this project did not technically intend on having a leader because it is a group project, I found myself playing the leader role from time to time. For example, setting up meeting times, making sure everyone finished a task on time, making sure all documents were turned in, etc. I think it is important to have someone in a team be the one to make sure everything is done on time... it is very important to make sure everyone is consistently doing their job and working out problems to move the project forward.”
- Communication Skills:
  - “I learned to be confident in voicing opinions, even if the entire group is in disagreement. I understand the importance of coming to a mutual agreement on issues that may or may not be as important to the team as it is to yourself.”
  - “I learned many things about myself... and discovered talents that will help me in my career. I learned that I should never overlook others opinions and be confident enough to express my own.”
  - “We are all busy college students with other assignments to worry about, so communication was really key. My group decided to meet in person a lot in the beginning of schedule, to get a sense of what everyone’s vision was. As the days continued, we communicated more through text message

and email, and completed personal work that was delegated in prior meetings. We had a final meeting all together, where everyone got to touch base and get unanswered questions addressed”

- Conflict Resolution:
  - “When I noticed after the first week that one of our group members had not participated in the project at all, nor had he even spoken a single word, I let him know that he needed to change. I expected conflict, but I learned that positively addressing an issue can lead to positive results. He quickly took responsibility as the rest of the group welcomed his input.”
  - “I found it easier to deal with it face to face and discuss the problems and possible reasoning. When conflict arise its best to keep a calm manner and be respectful while getting your point across.”

### *Observations*

Observations confirm the surveys and reflections above. It was very clear that working together in the teams proved challenging because the students had no prior experience working with each other and the team was not provided with a clear leadership hierarchy. At the start there was some audible grumbling in the individual classes about the lack of information exchange and the students from the other discipline being “from another planet”. However, with coaching in the individual classes to better prepare the students to respond to ideas and information received from the opposite domain, students began to embrace the project, become more flexible with their viewpoints, and found ways to successfully complete the project. Even with the initial challenges many students faced in coordinating schedules and clearly communicating their ideas, the students seemed to think the experience was valuable and important considering the professions they have chosen. The process gave them insight to the importance of collaboration, even at the introductory level. They learned important skills for communicating with other disciplines; the importance of neatly presenting ideas so those ideas can be conveyed in a visual form to clients, or in this case faculty; and many experienced a need for changing their viewpoint and opinion on the other disciplines knowledge, skill, and value that they can bring to the table during a collaborative project.

One observation made in the architecture school in the following semester to this project, was the use of the collaboration plan in a subsequent group project that was unprompted. In that follow up semester, teams of 10-15 students were tasked with building a site model in their architecture studio. Prior to beginning the work, the students wrote a collaboration plan for themselves. The students simply thought that planning a way to work together would help them achieve better results than operating without a plan.

Using these three assessment methods, it is clear that the two strategies employed were able to effectively communicate the importance of collaboration, demonstrate methods of collaboration between industry professionals, and allow students to collaborate in interdisciplinary teams on a project.

## **Discussion and Conclusion**

This project has led to several recommendations for instructors teaching collaborative practice. First, it is important to model effective collaboration. The discussion between the leadership of the involved academic departments and the discussion with the professional team were effective in helping achieve this goal. The students were able to hear from those who lead our schools and hear their support of the collaborative project and how it would support their future education. The professional team was probably the most enjoyable portion of the collaborative endeavor because the students were impressed by the work and the camaraderie that was evident between the participants. Not to be overlooked, is the essential dedication by the faculty of the collaborative project. If the instructors do not fully support collaboration as a fundamental skill, students will not engage and participate to their full ability.

Second, it is important to give students enough information and skills in their own discipline so they have something to offer the collaborative group. For instance, a design student should be able to draw a dimensional plan and section that can be used by the construction science students to estimate quantities. And, a construction science student should know the basics of putting together a schedule and budget. When in a collaborative group, each person should have the confidence to carry out their specific tasks. Making sure the individual classes provided enough detail for the students to complete their required tasks added to the success of the project.

Third, teaching collaboration should focus on techniques and skills that can continue to be practiced in the future. In the case of this project, the collaboration plan offered that opportunity. The focus of this project was the collaboration plan and the drawings, budgets, and schedules simply offered the opportunity to go through the motions of completing a project. The valuable, learned skill that came out of this project was the development of a leadership plan, common goals, open communication plan, conflict resolution strategy, and trust building techniques. These skills were acknowledged by many of the students as seen in their reflections.

Finally, just like the specific skills associated with each discipline, the students will not master collaboration after one project. These skills will need to be repeated and practiced during and after their education in order for the students to become effective collaborators.

With the growth of advanced project delivery methods the need for developing collaborative skills that involve teamwork and communicating with other disciplines is invaluable. Through the collaborative joint classroom experiences, students have acknowledged that these skills can be learned and appreciated at a foundational level in their undergraduate education. Even though domain specific skills are at their infancy, students were able to model collaboration through the development of a collaboration plan and complete a basic project. Coupling the techniques of modeling collaboration through professional project team presentations in the classroom and interdisciplinary collaborative projects with appropriate scaffolding of skills throughout the course has shown impact on students ability in learning valuable skill sets that can benefit them throughout their education and into their professional careers.

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