

A Case Study in Pedagogy for a Cross-Disciplinary Architecture/Construction Program

Thomas Leathem, CPC, Emily M. McGlohn, Alexis Gregory, Hans Herrmann, and Lee Carson
Mississippi State University
Mississippi State, MS

In the academic disciplines of the built environment there has been a notable increase of collaboration among the architecture, engineering, and construction disciplines. Research on these efforts indicates quantifiable benefits to the approach. However, most of these endeavors have taken place at the graduate level or upper-level of undergraduate programs. It is the belief of the authors that students and industry can benefit from earlier and prolonged exposure to their discipline counterparts. This paper examines efforts of faculty in separate construction and architecture programs at Mississippi State University in the development and execution of a collaborative course series for undergraduate construction and architecture students. Aspects of program objectives, curriculum development, pedagogical approach, and faculty involvement will are presented. The goal of the paper is to document the curricular activities that were planned and to share what actually happened so that the lessons learned may be used to help progress similar efforts at other institutions.

Key Words: Collaboration, Studio, Curriculum, Cross-Disciplinary, Project-based

Introduction

For decades the design-bid-build delivery method has been the standard approach for project delivery. This method situates a hierarchical system to building project delivery in which design is completed first and then a bidding process conducted to select a contractor. Benefits of this approach have been proposed to include – 1) Lower Project Cost, 2) Avoiding Contractor Favoritism and, 3) Improved Owner Clarity of Design Prior to Construction (Gordon, 1994). Research to the contrary has identified flaws in the approach such as increased timelines, poor communication, and adversarial relationships (Kramer, et al. 2007). A study done by Burr and Jones (2010) further supports this, indicating poor communication, differing backgrounds and cultures, and misunderstanding of the concept of collaboration as the main catalyst for contention among architects and contractors. These issues have given rise to adoption of more collaborative delivery methods. As buildings increase in complexity, other collaboration methods where designers, builders, engineers and consultants come together much earlier in the process to design and construct a building have gained popularity (Duggan and Patel, 2014).

Mimicking the industry in practice, the design and construction disciplines within academia have historically been segregated in the U.S. (Holley and Emig, 2011). In recent years however, the concept of multidisciplinary collaborative education has become a topic of major priority (Septelka, 2002). Programs implemented at the University of Washington and Auburn University provides two examples of initiatives taken by higher education institutions to adapt to this change (Septelka, 2002; Holley and Emig, 2011). Other ad hoc projects have been undertaken by other universities across the country, such as the University of Oklahoma and California Polytechnic State University (Ryan and Callahan, 2007; Montoya, et al. 2009). Results of these efforts indicate benefits to the approach.

Initial industry practitioner interaction, common among many of these studies, indicates the models better prepare students for challenges of the industry and help develop a collaborative discipline early in their career (Montoya, et al. 2009; Holley and Emig, 2010). A 2003 case study of a Collaborative Sustainable Construction and Design course indicated that students recognized the extent to which design and construction rely on each other to deliver a complete solution (Holley and Dagg, 2005). Through the positive student/industry feedback, initial successes of these programs suggest a cross-disciplinary collaborative model improves the potential for project success within the architecture and construction disciplines. In addition to student benefit successes, these efforts have also identified factors for consideration in further studies.

Outcomes for further consideration in collaboration attempts have identified timing, cultural divide, team building and communication skills, and academic divide as potential barriers to success. Studies have indicated entire quarters or semesters rather than short learning modules/activities are necessary to the intended success of cross-disciplinary approaches (Robson, et al, 1996; Septelka 2002). This is primarily due to differences among the disciplines which impact their propensity to communicate with one another. Oftentimes curricular challenges among the disciplines exacerbate the cultural challenges. A study by Migliaccio, et al (2014) noted common curricular differences between construction and architecture disciplines as key barriers to implementing a collaborative course. The pilot pedagogical approach in this paper builds on these suggestions and differentiates from previous studies through a multimodal strategy with construction and architecture students.

It is the belief of the authors that students and industry can benefit from earlier and prolonged exposure to their discipline counterparts. Septelka (2002) acknowledges this saying "the concept of collaboration…needs to be fostered early on in the student's academic experience and often." However, how do you attempt to teach cross-disciplinary collaboration while still teaching discipline specific fundamentals? The approach outlined in this case study presents a proposed approach to addressing this notion. Aspects of course objectives, curriculum development, pedagogical approach, and faculty involvement will be presented. The goal of the paper is to document the curricular activities that were planned and to share what actually happened so that the lessons learned may be used to help progress similar efforts at other institutions.

Case Study

Overview

The approach taken between the Building Construction Science program and School of Architecture at Mississippi State University employs the ideals of exposing students to collaboration early and often while trying to overcome some of the challenges identified in previous studies. With this in mind the pedagogy is divided into two semester components called Collaborative Studios I (CS I), and II (CS II). Collaborative Studio I takes place in the fall of a student's second year, while Collaborative Studio II takes place in the spring of a student's third year in their respective program. The intent of this approach is to provide one full year of separation between the experiences allowing for maturity and intellectual development. As such the curricular aims for each semester are vastly different.

In Collaborative Studio I the curricular aim takes a more fundamentals approach, acknowledging the students in the course are lower-level students just starting their second year of college. The student experience is much more hands-on and focused around breaking down barriers between disciplines. In contrast, Collaborative Studio II is more conceptual in nature recognizing the students have a deeper foundational knowledge and heightened maturity level. In addition to these aspects the faculty hypothesize collaboration between these students should be improved due to the experience from CS I. This scenario cannot yet be evaluated given the program has only competed its first year and students in CS II did not benefit from Collaborative Studio I. However, students participating in the inaugural experience of CS II will provide a good baseline for future analysis of the hypothesis.

Each collaborative course is a six-credit per semester studio format that meets 12 hours per week. Other programs have also used a studio construct as a means for collaborative engagements (Dossick and Pena, 2010). Unlike traditional lecture type courses a studio format provides increased student contact hours and a classroom construct conducive to prolonged collaboration. Studio classrooms are populated with workstations that are assigned to students for an entire semester. The assigned space becomes their personal workspace that they have access to at all times for the semester. This reduces the challenge of students trying to find a common ground to meet outside scheduled class hours. Additionally, studio courses typically meet between 8 to 12 hours per week for scheduled class time. The increased contact hours offer a two-fold benefit – First, students are provided increased scheduled work time for their projects as well as increased opportunity for cross-disciplinary interaction. The increased interaction helps break down the traditional cultural barriers to communication. Secondly, the added contact time provides moments for increased faculty feedback and development of communication.

Each collaborative studio serves every architecture and construction student in their respective year levels. Consequently, class sizes are typically 40 to 50 students for each studio. Given the class size and nature of the courses being project-based, organization and management had to be heavily considered. A typical studio format will have a student faculty ratio around 15:1. To facilitate this, three to four faculty representing both disciplines are assigned to each studio.

The classroom relationship between disciplines is possible due to the construction program's unique studio based curriculum. Rather than the three-hour lecture course typical in most construction programs, the Building Construction Science program at Mississippi State University uses an architecture framework of a six-credit studio. At its conception, the program's intent was structured to accommodate interaction between the architecture and construction disciplines. The common classroom frameworks and schedules facilitate interaction and eliminate the schedule challenges identified in attempts at other schools.

Developing the objectives and learning outcomes for the program required a collaborative approach amongst architecture and construction faculty to ensure necessary learning outcomes were being met. The faculty met over the summer of 2013. The tasks for the summer included the establishment of common ground between the disciplines (a common goal), a collaborative pedagogy (an ethos of one), and joint assignments that would ensure learning outcomes related to the pedagogy. Careful consideration to the development of these objectives also had to acknowledge associated accrediting bodies of both disciplines. As such an in-depth evaluation of American Council for Construction Education (ACCE) and National Architectural Accrediting Board (NAAB) requirements were conducted. The results of these efforts formed the goals and objectives of the two courses (Tables 1 & 3).

Collaborative Studio I

Collaborative Studio I is situated in a design/build format utilizing a small project that the students have to design and then construct. The design/build approach is an important aspect of the collaboration because it gives all students a common goal for the semester. As well, it provides a vehicle for teaching the fundamental aspects established in the course objectives. Collaborative aspects in CS I were set more at the grass roots level of working to break down barriers and develop communication skills. Students are required to develop, apply, and communicate their individual expertise to design, plan for, and construct a shared project. The semester is broken into two major elements – design then build. This particular semester focused on design and construction of bus stop shelters for a neighboring community.

Table 1

Collaborative Studio 1 Course Objectives and Accreditation Criteria

OBJECTIVES:

- Develop a working knowledge of the principle construction material families and their related construction methodologies
- Learn fundamental concepts of formal and spatial manipulation
- Develop an understanding of the relationship between design and construction professionals and their respective values
- Use drawing (analogue and digital) as a means of testing and developing design concepts and construction means & methods
- Understand how design is an informed process which gathers information and parameters from many sources of input
- Build verbal and non-verbal communication skills
- Develop awareness of cost, time, and quality as a factor affecting project outcomes

ACCE CRITERIA

GE.1	Oral presentation, tech writing, business writing
CS.1.D	Soil Mechanics
CS.2.B	Analysis and design of architectural systems
CS.2.E	Analysis and design of structural systems
CS.3	Construction Methods & Materials
CS.4.E	Computer applications (CAD and BIM)
CS.5	Construction Surveying
CN.1.A-C	Cost control data and procedures
CN.2.A-D	Planning and Scheduling
CN.5	Safety
CN.6.F	Quality control philosophies and techniques

NAAB CRITERIA

A.2	Design Thinking Skills: *Ability to* raise clear and precise questions, use abstract ideas to interpret information, consider diverse points of view, reach well-reasoned conclusions, and test alternative outcomes against relevant criteria and standards.
A.3	Visual Communication Skills: *Ability to* use appropriate representational media, such as traditional graphic and digital technology skills, to convey essential formal elements at each stage of the programming and design process.
C.1	Collaboration: *Ability* to work in collaboration with others and in multi- disciplinary teams to successfully complete design projects.
C.6	Leadership: *Understanding* of the techniques and skills architects uses to work collaboratively in the building design and construction process and on environmental, social, and aesthetic issues in their communities.

The faculty used a scaffolding approach to guide the students through the two major elements toward the end goal of building the full-scale bus shelters. Scaffolding in educational theory is a concept similar to scaffolding used in construction, in which concepts and skills build on each other to achieve the intended goal. This approach took an evaluation of the inherent elements of the end product and broke them down into incremental assignments over the semester (Table 2). The semester starts with basic aspects of understanding design conventions along with materials & methods of construction. Over the course of the semester varying degrees of constraints are introduced with respect to materials, cost, time, and logistics. During this time architecture and construction students collaborate to understand respective intricacies and project evolution to address each challenge. Many solutions derived are educated assumptions that students then get to test through the building of the actual project. The building process also provides greater depth of content understanding studied earlier in the semester while adding additional elements of necessary collaboration and communication.

Table 2

CS I Assignment Structure

Assignment	Objective
○ Assignment 1.0: Scavenger Hunt	○ Team Building
○ Assignment 2.0: Clay Model	○ Form & Structural Order
○ Assignment 2.1: Group Clay Model	○ Optimized Design through Collaboration
○ Assignment 3.0: Concrete Design/Construction	○ Design & Constructability Understanding
○ Assignment 3.1: Group Concrete Mockups	○ Optimized Design through Collaboration
○ Assignment 4.0: Material Synthesis	○ Challenges Uniting Materials
○ Assignment 5.0: Value Engineering	○ Optimization of Quality, Cost, and Time
○ Assignment 6.0: Project Docs & Build	○ Planning & Reflection of Oral and Written Communications

Collaborative Studio II

Collaborative Studio II attempts to mimic more of a real-world project approach in which designers and constructors get together at the early stage of a project to collaboratively develop the project plan from a design and construction viewpoint. Rather than students designing and actually building a smaller project, the project is larger in nature and focuses on content more aligned with the pre-construction phase of a project. Collaboration development is situated more at a contractual level and how the two disciplines work together in practice. Students were told their goal is to collaboratively develop a project proposal that emphasizes "client value". This term is couched in the criteria of optimizing the design to fit the client's needs while maximizing quality, cost, time efficiency, and safety.

Structurally students were divided into cross-disciplinary teams of construction and architecture on the first day of class, in which they remained throughout the semester. Teams for comprised of between 4 to 5 members in an attempt to allow for equitable participation by all students within a team. While this was helpful for faculty in controlling student participation it also created more teams for the faculty to manage. One problem faculty were concerned about in taking a conceptual approach was the common issue of construction students feeling they can't do anything until design work is done. In an attempt to curb this issue the students were provided with a program for the project on day one. Faculty selected a fire station for the project, feeling that the building type provided needed project constraints to maintain design limitations. Additionally, the faculty recognized students from both sides would need to build their knowledge of the building type to affectively meet the required objectives. The fire station allowed for multiple research resources to accomplish this.

Table 3

Collaborative Studio II Course Objectives and Accreditation Criteria

OBJECTIVES:

- Students will build an understanding of the relationship with and values held by their building industry partners
- Students will develop a working knowledge of brick masonry and steel frame construction and their related construction methodologies
- Students will learn the relationship of space planning to form making
- Students will learn construction budget estimating and scheduling
- Students will learn the importance of Building Information Modeling and Integrated Practice as a means to foster the above listed goals and objectives

ACCE CRITERIA

GE.1.C	Oral presentation, tech writing, business writing
CS.2.A	Analysis and design of civil systems
CS.2.B	Analysis and design of architectural systems
CS.2.D	Analysis and design of mechanical systems
CS.2.E	Analysis and design of structural systems
CS.2.F	Building codes and standards
CS.3.A	Composition and properties of materials
CS.3.B	Terminology and units of measure
CS.3.C	Standard designations, sizes, and gradations
CS.3.E	Products, systems, and interface issues
CS.3.F	Equipment applications and utilization
CS.3.H	Assembly techniques and equipment selection
CS.4.B	Graphic vocabulary of orthographic and other drawings
CS.4.E	Computer applications (CAD and BIM)

NAAB CRITERIA

A.2	Design Thinking Skills: *Ability to* raise clear and precise questions, use abstract ideas to interpret information, consider diverse points of view, reach well-reasoned conclusions, and test alternative outcomes against relevant criteria and standards.

A.3	Visual Communication Skills: *Ability to* use appropriate representational media, such as traditional graphic and digital technology skills, to convey essential formal elements at each stage of the programming and design process.
B.7	Financial Considerations: Understanding of the fundamentals of building costs, such as acquisition costs, project financing and funding, financial feasibility, operational costs, and construction estimating with an emphasis on life-cycle cost accounting.
B.10	Building Envelope Systems: Understanding of the basic principles involved in the appropriate application of building envelope systems and associated assemblies relative to fundamental performance, aesthetics, moisture transfer, durability, and energy and material resources.
C.1	Collaboration: *Ability* to work in collaboration with others and in multi- disciplinary teams to successfully complete design projects.
C.6	Leadership: *Understanding* of the techniques and skills architects use to work collaboratively in the building design and construction process and on environmental, social, and aesthetic issues in their communities.
C.9	Community and Social Responsibility: Understanding of the architect's responsibility to work in the public interest, to respect historic resources, and to improve the quality of life for local and global neighbors.

Just as with Collaborative Studio I, a scaffolding technique was used utilizing assignments to systematically build the project proposal over the course of the semester. Students were given a request for proposal outlining the project requirements and the building program. A team-building exercise kicked off the semester where each team had to develop a team name predicated on a holistic integrated team strategy. As with CS I students all received the same assignments. Work was distributed between individual and group responsibilities on about a 60/40 split, respectively. While some assignments were completely individual, others were a combination of individual and group. The intent behind this was to provide a systematic way of assessing individual student competency and then competency from a teamwork perspective. The finality of the course was team presentations of their proposals in a pinup jury review format. The jury was comprised of industry representatives providing feedback on each presentation and ranking the proposals.

Lessons Learned

Team Building & Communication

One of the major goals of the Collaborative Studio sequence is development of effective communication and collaboration. In CS I this was clearly seen as we moved through the semester. Students from both sides came into the beginning of the semester with the proverbial preconceived notions of each other. Some students quickly began interacting across aisles while others seemed to cement their original beliefs. Some teams had frequent disputes and simply refused to work with each other. However, by the end of the semester most all students had found some level of common ground and recognized the value each other brings to the process. Aspects of increased communication and collaboration were well acknowledged during the build process where faculty witnessed architecture and construction students discussing with each about strategies to complete work elements and solve issues that arose. In CS II the same was noted during the final project jury reviews where students were addressing questions across disciplines from jurors. One juror noted how impressed they were to see construction students responding to design focused questions while architecture students were addressing construction related questions. Jury members even began crossing discipline lines in questions to the students.

Faculty Involvement

Entering into this study the faculty recognized it would require an increased time commitment compared to that of a traditional studio course. However, the actual amount of time required and factors requiring extra time were not fully anticipated. In general the faculty in both semesters averaged invested time outside of scheduled class time. Various factors contributed to this from assessment, content coordination, student and student/group issues, evaluation and adjustment of strategies that weren't working, and generally working to understand each other's discipline. Assessment was a big factor that wasn't anticipated. While assessment strategies were discussed in the planning stages, it wasn't until actual assessment of student work when faculty realized conflict in philosophies on assessment. A great deal of time and compromise had to be reached to navigate this factor. Many of the factors requiring time investment are just as valid in a traditional classroom. What added to the time investment in this scenario was primarily trying to understand and be respectful of each other's discipline.

Challenges

The nature of a collaborative pedagogical approach contains inherent challenges regardless of knowledge possessed by the team members. This facet is exacerbated when adding limited knowledge on the content being addressed; i.e. lower-level undergraduate student's still learning discipline specific foundational knowledge. While there were clear successes related to communication and collaboration, there is a concern as to what cost these successes may have come in learning discipline specific fundamentals. Faculty on the construction side especially noted concern that the beginning of the CS I semester was very heavy in design theory which detracted from learning fundamental construction knowledge they would have received in a traditional course. This notion was supported by construction student comments. In response, the faculty intend to make adjustments for the next year wherein there is more disparity between the disciplines so that knowledge can be gained. However, care has to be taken not to shift too far in the other direction where an "us and them" atmosphere emerges.

All projects were developed as group projects to instill the collaborative dynamic. However this created great confusion among the students with respect to deliverables. Further, it created confusion for faculty on accurately assessing individual student performance. Moving forward efforts need to be made to try and isolate individual and group work so learning outcomes can be more accurately assessed between individual and group objectives. This may be more difficult to do in the first semester given the nature of the work. Nevertheless, assignments should be divided between group and individual work focusing on the following major objectives for each:

Individual Work: The objective is to evaluate each individuals core competencies related to technical skill such as material & methods understanding, drawing conventions, estimating, scheduling, spacial planning, coordination, etc.

Group Work: The objective is to evaluate ability to effectively communicate, coordinate, synthesize and accurately represent information as a team. Elements of evaluation might include: homogeneity of individualized work, graphical representation, clarity of roles & responsibilities, procurement, labor management/coordination, design coordination and communication.

Conclusion

Outcomes of the Collaborative Studio experience follow suit with much of the research from other institutions endeavors. It is clear the approach has benefits and warrants further investigation. Some of the success realized at Mississippi State University may not be as easily achievable by other programs when considering a studio-based approach. Regardless, any institutions considering a cross-disciplinary approach should pay careful consideration to the commitment required by faculty and administration.

There is a tremendous amount of time required for success of the approach. While the authors did not keep a log of time invested, we can conservatively say 30 hours a week per faculty member has been invested. Faculty and administration considering such an endeavor should be aware of this beforehand. Additionally, administration need to recognize their support through faculty release time, funding, and equipment is critical for success. Aside from the time commitment is the commitment toward understanding the idiosyncrasies of each other's discipline. Successfully trying to facilitate learning of collaboration across disciplines first requires willingness of faculty to collaborate across disciplines. It cannot be faked and the students will be the first to recognize a disingenuous attempt.

The collaborative course series between Building Construction Science and the School of Architecture at Mississippi State University has completed its first year. Preliminary outcomes indicate some learning objectives being accomplished. Anecdotal evidence indicates some positive outcomes toward development of discipline specific knowledge and cross-disciplinary understanding, as well as improved communication skills. Reviewer comments on the end of semester projects do suggest some level of success toward discipline specific fundamentals.

While this evidence is positive, no quantifiable information has been collected on outcomes achievement. The authors intend to focus further research in these areas.

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