Developing a Request for Qualifications Activity to Integrate Construction Topics at the Sophomore Level

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The present paper describes our experience in planning and piloting a seven-hour practical activity (called "Integration Lab") that integrates company management, estimating, scheduling and presentation skills, within a larger, 9-credit hour, construction management sophomore-level course. The scenario chosen was the response for a request for qualifications (RFQ) obtained from a previous student competition and modified to match the course learning objectives. The experience was divided in three days, culminating in a presentation to industry professionals in the third day. Results show that the activity was highly engaging to students due to its authenticity and having industry professionals as judges, though time management to put the document and presentation together was a struggle. Industry professionals were positively encouraged by the results, especially given that these were sophomore-level students, and commented the importance of training students in presentation skills throughout the construction management curriculum. Finally, from the instructors' perspective, seeing students highly engaged was a motivating factor, however some improvements should be made for the future, such as (1) spreading the integration lab sections into more weeks of the semester, (2) more scaffolding of students in regards to expectations for the written and oral presentation, and (3) allocating more points to the activity as a whole. We expect this paper will shed a light for other instructors who are considering developing integrating activities within their construction curriculum.

Introduction

Recent reports related to the U.S. construction industry indicate that more collaborative delivery methods such as Design-Build (DB) are becoming increasingly representative in the construction market [1], [2]. One of the greatest claim for the use of DB is that it allows for accelerating the schedule by making use of fast-track techniques [3]. However, research indicates that for a successful DB project, it is necessary to have improved communication between all stakeholders, including between owner and design-builder [3]. The link between effective communication and project success suggests that a successful construction manager not only needs technical knowledge, but also 'soft skills.' [3], [4].

Similarly, a shift on how higher education institutions view undergraduate teaching is also happening. Research in student motivation indicates that learning becomes more meaningful to students if they learn things *they* perceive as needed [5]. This means "simply telling students that they will need certain knowledge and skills some day is not a particularly effective motivator" [5] and requires a shift in how academics think about instructional delivery. The need to better align how undergraduate faculty teach to how students best learn has yielded several alternative instructional delivery methods which are more student-centered, rather than only relying on the traditional, teacher-centric lecture. Most of the new proposed instructional methods often involve active learning and working in groups as a way to stimulate students' construction of knowledge.

Within those student-centered methods, project-based learning (PBL) seems naturally a good fit for instruction in undergraduate construction education, given that the Architecture, Engineering, and Construction (AEC) industry is based on the development of unique projects

[6]. In addition, PBL has been increasingly used in construction education curriculum with positive results [7], [8], [9]. However, researchers caution that merely having projects within courses does not necessarily equals the use of PBL [8].

In this paper, we present our experience in the planning and piloting a seven-hour active and collaborative learning activity, referred here as "Integration Lab." This activity was the last practical activity in a 9-credit hour construction management, sophomore level course. The content of the activity included company management, estimating, scheduling, and oral and written presentation skills, and used a Request for Qualifications (RFQ) prompt, obtained from a national student competition (faculty obtained authorization from the organizing institution to use it in the course) and modified to meet the learning objectives for the course. Our contribution lies in providing our example to other faculty of lower level courses (e.g., freshman and sophomore level courses) in construction management undergraduate programs who are considering integration of topics and project-based activities in their courses.

Background Literature

Since the turn of the Millennium, questions about the effectiveness of the traditional teaching pedagogy have risen [10]. Despite those questions, a large part of the construction undergraduate curriculum is still taught the traditional way, which can be described as deductive teaching, and content is delivered through several separate courses. An example of deductive teaching is the traditional routine of student being taught the theory by an instructor, followed by some knowledge practice (such as activities or exercised) and finally, real world application, though not all courses may reach this final step [5], [11].

In construction education, few institutions have identified that a change is needed and as a result have pushed for curriculum change, in order to provide instruction that is more engaging to students as well as adequate to the needs of the AEC industry. Examples of construction programs that have attempted a holistic response to this need are California Polytechnic State University (for reference, see [12]) and more recently Purdue University (for a review of their framework, see [13] and [14]).

One of the ways to improve construction curricula has been to use active learning methods and more inductive teaching. Because there are several ways to achieve active learning, previous research has broadly defined the term as using learning methods that are engaging to students [15]. Active learning describes a range of different methods within the larger umbrella of inductive teaching. Inductive teaching methods are student-centered and commonly use active and collaborative (and cooperative) learning approaches. The main focus in inductive teaching methods is for students to discover or realize the importance of concepts as a result of working in a specific learning activity. These activities most likely should echo activities they would perform in their professional lives [5]. Within the range of instructional methods that are considered active learning and inductive learning, we will further discuss Project-Based Learning (PBL) as the method chosen for the instructional intervention described in this paper.

In PBL, learning occurs around projects, which should replicate situations (and projects) professionals should encounter in their fields [8], [16]. In an attempt to help with the definition of project-based learning, previous research has identified certain characteristics that would be included in a PBL curriculum: projects as drivers of the course content and student discovery; projects should instigate an investigation; projects should encourage student autonomy; and projects should be an authentic representation of the professional environment [16]. Previous research on student cognition and self-motivation indicates the benefits of authenticity towards student engagement and retention [17], [18]. However, even though students' autonomy is encouraged, it is important to note the need for scaffolding through the process of discovery. Examples of scaffolding can be breaking down of tasks into smaller tasks that can then be managed by the students without overwhelming them, as well as providing formatting feedback within the duration of the project [16].

With more authentic tasks, the importance of 'soft skills' is greater than in the traditional deductive way of teaching, especially if active learning is coupled with collaborative learning activities. [19] found that all students in the two iterations of a PBL residential construction course felt they have learned more working in groups, which is consistent with research in the current generation of construction undergraduate students [20]. This is promising, as previous research in the AEC industry has shown the importance of developing trust, collaboration, and effective communication towards project success [3], [4] and that accrediting bodies of construction and construction engineering education [21], [22] require that students be able to contribute as part of a team.

Instructional Context and Methodology

As mentioned previously, the Integration Lab activity is part of a larger, 9-credit hour, sophomore level course at Purdue University. The class meets in large groups twice a week, for approximately 3 hours each meeting, and then in smaller groups twice a week for another approximately 3 hours each meeting, for a total of 12 contact-hours per week. The Fall 2018 course was the first time it was offered and had a starting cohort of 39 students, with only 38 students at the time of the activity (last three weeks of the semester). The 9-credit hour course is focused on pre-construction management activities and integrates several topics, such as statics, soils, sustainability, plan reading, estimating, safety, scheduling, accounting and project management. In addition, within this course, students are presented with 8 hours per semester of instruction related to each of the five concentrations they will have to choose before moving to their third year in the construction management program (commercial; disaster restoration and demolition; healthcare; mechanical, electrical and plumbing; and residential). Additionally, students also receive 8 hours per semester of instruction related to design and construction integration. The learning outcomes for the overall course are:

1. Calculate design components of a construction project during the pre-construction phase.
2. Produce project controls required during the pre-construction phase of a construction project.
3. Construct pre-planning documents relevant to beginning a construction project.

4. Apply project administration to a construction project utilizing the required documentation and technology available within the current construction industry.
5. Show professionalism by applying proper communication, teamwork, rules & regulations, and level of detail required within a construction company and on a construction jobsite.

Usually students are able to take this 9-credit hour course during either their third or fourth semester in the program, however, for this specific semester all students were in their third semester of their construction related program. Previously, students in this cohort had two construction-program specific courses – a 3 credit hour introductory course and a 6 credit hour construction management fundamentals course. The first introductory course is a survey of the construction industry, and includes topics related to the overall construction process, career opportunities, and an introduction to construction materials, management and technology tools used in the AEC industry. This introductory course also includes one module on delivery methods, during which instructors discuss the differences in project delivery, procurement and contracting methods. The first introductory course is an 'open course', meaning it may be taken by any student registered at that Purdue University Main Campus. The second course focuses on construction materials and methods, contracts and construction layout techniques, and students in that course will acquire skills in quantity estimating, plan reading, project layout, and project documentation. Students in the second course had continuous exposure to hands-on activities and teamwork and only students in the construction management program or construction management minor are allowed to take this course.

Therefore, students of the current course had previous experience with hands-on projects and teamwork, as well as exposure to different project delivery methods, but did not have experience in professional presentations or formatting of complete document packages prior to the 9 credit hour course in which the Integration Lab was embedded. Both preparatory construction management courses we taught by multiple instructors using active learning techniques, therefore the sophomores included in the cohort of this exploratory study did not experience traditional, siloed learning experiences within their construction management program, though the level of hands on and active learning techniques used by each of the instructors in each module within a course may vary.

During the semester, students have three exams and four projects. The four projects given to students in Fall 2018 were: Project 1 – Bluebeam 'Certification'; Project 2 – Neighborhood and Zoning Analysis; Project 3 – Finishes Take off and Estimating; Project 4 – Sustainability Proposal. The Integration Lab was not a project in the Fall of 2018 semester, but it was given in the last three weeks of the semester as a context for the small group meetings and had the following learning objectives:

1. Students should be able to provide a professionally formatted, holistic document (meaning, the document should look like it was done by a cohesive group of people, language use should be the same throughout and format should be consistent).

2. Students should be able to provide a professional presentation to a group of industry judges in a low risk environment.
3. Students should be able to provide an organizational chart for the project, with job titles of all involved in the effort.
4. Students should be able to provide a minimum of 30 activity pre-construction schedule (which means focused on activities prior to mobilization that will happen during the validation phase)
5. Students should be able to provide a cost estimate for personnel and materials of the validation phase (which will include design, construction management and permitting activities).
6. Students should be able to elaborate technical narratives that bind the project information in a way that addresses clients concerns for the requirements of the RFQ.
7. Students should be able to work in groups by distributing responsibilities and duties and transforming group work into a cohesive oral and written response to the RFQ.

The decision for not making the Integration Lab a course project was made to keep this activity as a low-stake activity for students. The total points for the class were 3,500, with each project accounting for 200 points. The total points for the Integration Lab were 85 points, spread out in five different submissions that will be discussed in the following section (Activity Preparation). Two instructors and one teaching assistant were responsible for the small group instructions. The same two instructors, in addition to six industry professionals were part of the panel to which students presented their Integration Lab projects. The prompt for the Integration Lab was originally obtained from a national student competition, and then modified to meet the learning objectives desired by the instructors.

The prompt presents a Request for Qualifications (RFQ), which is a procedure used in two-step procurement procedures in Design-Build projects. The first step being a RFQ, which focuses on the qualifications of the design-builder for the project; and the second step is a Request for Proposals (RFP), which involve a more detailed approach to the specific proposal, often requiring initial design proposals, price and schedule proposal (price and technical proposals). The construction management program in this study has been using a RFP as guiding activity for the senior capstone course for the past five years. To provide readers with a better sense of the curriculum progression of the construction program at the authors' institution, the course learning outcomes for the senior capstone course are: (1) synthetize all the components of a successful design-build project from start to finish; (2) solve complex problems for outside stakeholders with interdisciplinary teams; and (3) create and present professional communications in written and verbal forms both individually and as a team.

In addition, one of the course objectives for the senior capstone is to be able to prepare and professionally present many previously learned objectives in a comprehensive form in project simulations, including (but are not limited to) conceptual design of building, request for proposal (RFP), preconstruction services and others. In the capstone course (at the present moment a single semester course), the RFP is presented at the beginning of the course. Smaller submissions throughout the semester target specific deliverables of the RFP, students are given

feedback and then expected to resubmit the complete package towards the end of the semester and then present their work to a panel of industry judges. The RFP package used by the capstone course includes project management and marketing aspects, but also conceptual design, estimating and scheduling for the whole project. Projects vary each year, as well as per group within each semester. Groups are formed by the capstone instructor based on student interest (which are aligned with the available concentrations mentioned in previous section of this paper), and projects are also distributed based on the concentration focus of each group. Prior to the Fall of 2018, no other course in the construction program where the authors teach used an integrated RFQ or RFP activity before the senior year. In addition, it is important to note that two of the authors were course managers of the 9-credit hour course, and main instructors for the Integration Lab activity reported in this paper.

In order to provide a holistic picture of our experience related to the first pilot iteration of the Integration Lab, we will present the preparation, deployment and evaluation of the Integration Lab. In the preparation section, we will present our rationale for changing the original RFP and how to structure the small group sections to provide the guiding students needed to complete the project, as well as how the assessment of the activity was performed. Then, we will present our reflections as instructors of the activity and our impressions of the students' work. Finally, we will present the students' impressions of the activity and industry judges' perceptions of student group presentations.

Activity Preparation

Both course managers decided that they wanted some type of integration activity at the end of the semester. The RFQ activity was chosen as a logical mid-program preparation for the RFP activity that students are required to do during their capstone course. One of the course managers reached out at the end of August of 2018 to a professional association that organizes yearly student competitions to ask if they could use a previous competition prompt (and materials) in their class and received positive feedback, along with the materials.

During the following two months (September and October 2018), the material was revised to fit the course learning outcomes. Table 1 describes how each of the activity's learning objective matches three of the five course learning outcomes. Then, the original RFQ document was reviewed to match what the instructors envisioned for the activity, and the time limitations students would have.

Table 1. *Mapping of Activity Learning Outcomes*

Course Learning Outcomes	Activity Learning Objectives
Construct pre-planning documents relevant to beginning a construction project.	• Students should be able to provide a minimum of 30 activity pre-construction schedule (which means focused on activities prior to mobilization that will happen during the validation phase) • Students should be able to provide a cost estimate for personnel and materials of the validation phase (which will include design, construction management and permitting activities).

	• Students should be able to elaborate technical narratives that bind the project information in a way that addresses clients concerns for the requirements of the RFQ.
Apply project administration to a construction project utilizing the required documentation and technology available within the current construction industry.	• Students should be able to provide an organizational chart for the project, with job titles of all involved in the effort.
Show professionalism by applying proper communication, teamwork, rules & regulations, and level of detail required within a construction company and on a construction jobsite.	• Students should be able to provide a professionally formatted, holistic document (meaning, the document should look like it was done by a cohesive group of people, language use should be the same throughout and format should be consistent). • Students should be able to provide a professional presentation to a group of industry judges in a low risk environment. • Students should be able to work in groups by distributing responsibilities and duties and transforming group work into a cohesive oral and written response to the RFQ.

The object of the RFQ was maintained (a parking facility with recreating field and classrooms in a university setting), but the final document was modified to simplify the activity. One of the changes was the requirement of working in groups of 5 students to groups of 3 students (although there was one group with four students, because of odd class numbers). In addition, changes were made to fit the activity into the already established three small group meetings for the whole activity and one was already dedicated to the presentation. The intent was for students to do most of the work during the small group meetings, submit their work, receive feedback, and revised prior to their final submission. Therefore, one of the main changes was the removal of some of the design requirements of the RFQ, as most students, being construction management sophomore students, do not have a background in design and it would not be feasible to include it in such short activity. The original student competition called for multidisciplinary collaboration to tackle the design concept for the proposal. The following list includes the major revisions in the RFQ document:

- Learning Objectives for the Integration Lab were listed in the first page of the RFQ;
- Dates and deliverables were modified to more current dates and to reflect the time frame of the course and intent of the activity (including deadlines for deliverables);
- Point of contact for the RFQ changed to one of the course managers of the course (also instructor for this activity);
- Late submissions (up to one hour late) were allowed, with a penalty of 2 points deduction;
- Inclusion of an oral presentation requirement, with guidelines and prompt questions for students to prepare. The following were the prompt questions created for the oral RFQ presentation:
    - What methods will your team employ to plan for the current and future needs of the diverse groups of final users while maintaining project timelines? How will your team ensure that you engage with all College stakeholders in a meaningful way?

    - How will your team assess and evaluate the quality and quantity of classrooms, offices, parking facilities, exterior elements, and other types of spaces assigned to the new facility? How will you address site constraints and site planning?
    - What methods will you use to compare the proposed College new facilities with those of similar units at other universities?
    - How will your team evaluate multiple solutions to space needs and challenges, including the options of new buildings and of re-purposed, renovated, or rehabilitated space?
- Removal of the requirement for students to provide a comparative evaluation of two sites;
- Removal of Design Concept Presentation.

The total page count for the original RFQ was reduced from 37 to 25 as some sections were eliminated, as described above, or combined and simplified. The result was a grouping of the deliverable into three main instructional activities (excluding the presentation), which were planned to happen during two days at the end of the semester. Table 2 describes the RFQ section covered per instruction module. Even though students were not asked to provide conceptual design for the proposal, they were asked to provide two design references as well as sustainable options they could use under the section "Design Excellence Implementation in Design-Build." Two instructors were responsible for the activity, with one instructor in charge of the first module, the other instructor focusing on module 3. Originally, the instructor of module 1 would also be present for module 2, however due to personal reasons, the instructor was not able to be present on November 29th, and was substituted by a graduate teaching assistant (doctorate level), who has a background in architecture and more than 10 years in design development, management and also real estate development.

Table 2. *Proposed Instructional Modules for Integration Lab*

Instructional Module #	**Date Delivered**	**Duration (minutes)**	**RFQ Sections Covered / Deliverables (points)**	**Total Score**
1 (Focus: Project Management)	Tuesday, Nov 27th, 2018	120	• Resources in Design-Build Team (9 points) • Construction in Design-Build (3 points) • Prior Experience (3 points)	15
2 (Focus: Design)	Thursday, Nov 29th, 2018	60	• Cover Letter (2.5 points) • Design Excellence Implementation in Design-Build (5 points) • Team Statement (2.5 points)	10
3 (Focus: Schedule and Cost)	Thursday, Nov 29th, 2018	120	• Validation Phase Schedule (10 points) • Validation Phase Cost (10 points)	20

At the end of the day of each instructional module described in table 2, students were required to submit their work as a group and were evaluated regarding the completeness of their document, as well as given relevant feedback to complete their final submission (due December 3rd, 2018). The final submission was also evaluated in terms of completeness, which meant

having all sections of the RFQ submitted and complete; and formatting, which meant few or no spelling and grammar mistakes, and professionally formatted. The final submittal was worth 10 points.

Then, on Tuesday, December 3rd, students were asked to provide a 10 minute presentation to a panel of industry professionals. The small group meeting on that Tuesday started one hour later than the usual meeting, to allow students' further preparation, and the remaining 120 minutes were allocated for presentation and questions and answers (Q&A). To provide more authenticity to the task, course managers invited industry professionals to participate in an evaluation panel of the students' presentation. They were recruited from the program's industry partners (industry advisory board). In the call for industry professionals, instructors indicated the focus on giving student formative feedback and evaluating them on 1) overall presentation (flow, content…); 2) presentation material (slides, handouts, figures, tables, text size…); 3) questions and answers; 4) professionalism; in addition to an open-ended space for comments. The instructors also included the following language in the call:

> From our guest judges, we will ask you to rate the students using a rubric (see attached), but most importantly, we would like for you to give insights to them on (1) how to format their presentation professionally; (2) using a professional language; (3) how to professionally provide answers to questions; (4) how to deal with presentation anxiety and challenging situations; and (5) how to best sell their team during these presentations. Keep in mind that these are sophomore students, some of who may or may not have had a previous internship, and had limited time and experience to put this together. Our intention is that their presentations will be a learning opportunity to hear industry professionals' comments especially their previous experience in similar situations. As instructors, our hope is that this will inform and prepare them better for their senior capstone presentations moving forward.

The intent of the invitation was to make it clear for the industry partners the goals of the activity and how instructors were going to rely on them not only for scoring students' presentations, but also as consultants for students to improve on their presentation skills. Students were evaluated by the instructors and industry professionals using the same rubric for a maximum of 20 points.

Finally, a Qualtrics online debrief survey was created and sent to students after the completion of the presentation, and a peer evaluation was made available. The goal of the students' debrief was to obtain feedback from students as to how they felt about the activity and identify potential areas of improvement. Students were given 5 points if they complete most of the questions of the debrief survey, and were given 5 points if their peers evaluated them as a contributing team member. Therefore, the total points for the activity added up to 85 points (see table 3 for the complete breakdown of point information).

Due to the 9-credit hour course point limitation, instructors could not increase the number of points for the Integration Lab activity. However, to increase students' interest, instructors assigned bonus points for the three top performing groups in the presentation category and on the written report category, with students from the top performing group in each category gaining 30

bonus points, the second placing group 20 points and the third placing group would receive 10 points (these points were assigned to each student in that group).

Table 3. *Breakdown of points for the Integration Lab Activity (total = 85 points)*

Deliverable	Deadline	Points
Project Management – Preliminary Submission	Tuesday, Nov 27th, 2018	15
Design – Preliminary Submission	Thursday, Nov 29th, 2018	10
Schedule and Cost – Preliminary Submission	Thursday, Nov 29th, 2018	20
Complete Draft	Monday, Dec. 3rd, 2018	10
Presentations	Tuesday, Dec. 4th, 2018	20
Peer Evaluation	Friday, Dec. 7th. 2018	5
Activity Debrief	Monday, Dec. 10th, 2018	5

All materials (RFQ proposal, RFQ supporting materials, activity rubrics, bonus points information, group information and submission links (one for each day of activity, one for the complete written report, and one for the peer evaluation) were displayed on the learning management system used in the course (Blackboard Learn). In addition, the link for the lab debrief was made available after the presentations, in the same folder online.

Results

Student Survey Results

The first small group had 6 teams, with five teams of three students, and one team of four students. The second small group had 6 teams, all with three students. The total number of students in this activity was 37. However, only 20 students started submissions of debriefs using the Qualtrics online survey – a response rate of 54%. However, one student did not answer most of the questions. The instructors believe this is probably due to the low points assigned to the debrief activity.

The results indicate that students identified soft skills as the top three skills they have mostly used during the activity – oral communication, written communications and teamwork (see Table 4). This is somewhat expected as the goal of the project was to have an oral and written report, and students worked in groups. It was interesting to see students did not indicate risk management as a skill they have used during the activity, and this may be related to their sophomore level and their understanding of what is risk management in construction.

Responding students (n=19) found the presentations day (day 3) to be the most difficult day of the activity and the first day (day 1), which focused on project management, including the creation of company narratives, organizational charts and resumes as the easiest ($\bar{x}$ day1 = 3.53, Sday1 = 1.19; $\bar{x}$ day2 = 4.74, Sday2 = 1.52; $\bar{x}$ day3 = 5.11, Sday3 = 0.97). Instructors expected students to struggle more during presentation day, because this is the only day instructors were not acting as facilitators, but rather as judges of their work. However, it is interesting to see that the second day, focusing on design, estimating and schedule was also challenging to the students.

Unfortunately, the debrief survey sent to students did not separate the two instruction modules on that day, to evaluate which of the module (if not both) presented a challenge and why.

Table 4. *Skills identified by students as most used during the Integration lab activity (n=20)*

Skill	Average[a]	SD	Median
Create written communications appropriate to the construction discipline	5.55	0.94	5.5
Create oral presentations appropriate to the construction discipline	5.5	1.19	5.5
Create a construction project safety plan	4.2	1.64	5
Create project cost estimates	4.7	1.38	5
Create construction project schedules	4.9	1.12	5
Analyze construction documents for planning and management of construction processes	5.15	1.39	5.5
Apply construction management skills as a member of a multi-disciplinary team	5.7	1.34	6
Apply electronic-based technology to manage the construction process	5.15	1.76	6
Understand different methods of project delivery and the roles and responsibilities of all constituencies involved in the design and construction process	5.35	1.35	6
Understand construction risk management	4.5	1.64	5
Understand construction quality assurance and control	5.1	1.68	5.5
Understand the principles of sustainable construction	5.35	1.18	6

a = based on a 1 (not at all) to 7 (a lot) Likert-type scale

Seventeen responding students indicated they were happy to present in front of industry (n=18, with one student not making any positive or negative comments) and indicated they have learned a lot from the six professionals that came to class. Industry professionals (called judges) could ask questions to students after each presentation and did so, sometimes students were not prepared with responses and this was visible in the debrief – seven respondents indicated they were stressed during the presentation or in its preparation. Two responding students indicated they would have liked more time to prepare for the presentations, even though the presentation prompt was given to students at the same time of the RFQ. In addition to asking questions, course managers asked the industry judges to provide specific feedback to the presenting group or general tips for RFQ presentations during group transitions, which students indicated they enjoyed: "I think it was a great idea to have the people from the industry to come and evaluate us and give us their important feedback. I like how they told us specifics on what to do in an actual situation like this."

In terms of confidence, despite the stressfulness indicated in their responses to the debrief survey, students reported being confident in their performance ($\overline{x}_{confidence} = 5.15$, $S_{confidence} = 1.34$, n=19). In addition, working in teams was very well received by students, with 18 respondents indicated to somewhat agree, agree or strongly agree with the statement; and similarly 17 respondents indicated they somewhat agree, agree or strongly agreed to learning more by working in teams. In the survey, students indicated their strategy for working was

mainly based in splitting the work, with only one respondents indicating they strategized a "game plan for the whole project," but did not provide more information as what this meant.

In the debrief survey, students were asked to reflect on three lessons learned from the Integration Lab activity. The following list presents the grouped results by theme, as performed by one of the authors, based on the seventeen students who have responded to this question of the debrief survey:

1) Improve professional presentation skills (n=15)
2) Improve own learning skills (n=9)
3) Improve strategies for more effective teamwork (n=8)
4) Other (n=6)
5) Improve scheduling and estimating skills (especially related to software use)(n=4)
6) Improve their understanding of owners and owners' expectations (n=3)
7) Improve understanding of how teams are formed in a construction setting (n=2)

Finally, students were asked for two positive aspects and two improvement aspects of the activity. The most frequently cited positive aspects of the activity were its authenticity (n=12); followed by the availability of industry judges during presentations (n=10), and then teamwork (n=5). The following quote illustrates a student's thoughts of the positive aspects of the activity: "I liked how we had to work as a team to come up with this bid. That made it feel like we were a real company coming up with a bid for a project. I also like how we had people in the industry judge us." Other five positive aspects were also identified, but could not be grouped in to a theme.

Students were also very eager to provide suggestions for the improvement of the activity. The most frequently cited suggestion for improvement was to give students more time to work on the project (n=10). Students were presented with RFQ document in November 19th (Thanksgiving week), but only started working in small groups on November 27th. Then, students indicated they would have liked more explanation of the activity, including more information on expectations (n=7), followed by more information on scheduling and estimating of the activity (n=6), more points towards the activity (n=5), and more scaffolding during the activity (n=4), and not letting students choose own group (n=1). Given the open ended nature of the activity and the fact that this is the first time in the program that students are asked to provide a written document and oral presentation on an integrated material, the impressions of students are not unexpected. In addition, the RFQ scheduling and cost component asked students to provide an estimate for pre-construction activities (such as design, and cost to estimate the job), which is not something students were used to.

Finally, when asked for more information they would like to share, all four students who replied to this question indicated a positive view towards the activity, though two students demonstrated frustration for not being more prepared. Overall the following quote is encouraging: "I am very grateful for this experience as I believed it truly pushed my abilities to

do good work in a very limited time span. I also enjoyed how it stretched on what we have previously learned in class as well as stuff we have never seen before."

Industry Survey Results

Six members of the industry participated as judges to the students' presentations of the Integration Lab. The authors asked industry to rate what they thought are the skills students most used in the Integration Lab. An open invitation to the program's construction advisory board for industry judges of the Integration Lab activity was made in late September, 2018 and the full information (including the RFQ) was sent to the six industry professionals who positively replied the open call by November 19th, 2018.

Demographic information for the professionals who came to the presentation showed that the panel was composed by a diverse group with varying experiences. The years of construction experience of industry judges ranged from 10 to 42 and their professional position held at the time of presentations also ranged from general superintendent, project manager, and vice president. Industry professionals (judges) were also asked to answer a paper based survey, which contained questions related to the activity, but also related to their experience judging students' works. The first question of the survey asked industry professionals to evaluate the skills they though were necessary of students during the Integration lab. Table 5 shows the results of the rating of skills, and if compared to students rating shows different priorities. However, it must be noted that professionals were only present for the presentations, which may be why they have voted higher on that skill.

Table 5. *Skills identified by industry judges as most used during the Integration lab activity (n=6)*

Skill	Average[a]	SD	Median
Create written communications appropriate to the construction discipline	4.67	1.63	5
Create oral presentations appropriate to the construction discipline	5.33	1.63	5.5
Create a construction project safety plan	3.17	2.14	2.5
Create project cost estimates	2.83	1.17	3
Create construction project schedules	3.17	1.17	3
Analyze construction documents for planning and management of construction processes	3.5	1.52	3.5
Apply construction management skills as a member of a multi-disciplinary team	4.83	1.94	5.5
Apply electronic-based technology to manage the construction process	4.83	1.17	5
Understand different methods of project delivery and the roles and responsibilities of all constituencies involved in the design and construction process	5.17	1.47	4.5
Understand construction risk management	4.33	2.16	4.5
Understand construction quality assurance and control	4	1.41	4
Understand the principles of sustainable construction	3.83	1.47	3.5

a = based on a 1 (not at all) to 7 (a lot) likert-type scale

The industry survey also asked industry judges if there were any suggestions or comments about the activity and all participants provided input. Their input was grouped into themes by one of the author and are presented in the following list:

- Positive comments about the activity (n=4)
- Improve scaffolding of presentation skills by rehearsing more or watching senior capstone presentations (n=3)
- More scaffolding students in relation to what are the requirements and expectations of an RFQ (n=2)
- Other (n=2)

When asked about take-away knowledge that instructors could share with students about the experience, all six industry judges provided input. One of the authors has grouped their responses into five main groups:

- A better understanding about the client's needs and wants is essential (n=4)
- Presentation skills are very used in construction (n=2)
- Include more personality into presentations (n=2)
- Practice is key to improvement (n=2)
- Other (n=2)

Finally, despite students' open ended comments indicating stress with presenting to industry judges, our analysis showed that professionals were overall satisfied with the performance of students ($\overline{x}_{performance} = 5.83$ in a seven point scale, $S_{performance} = 0.98$, n=6). Open ended comments regarding the presentations given by industry professionals included a need for students to improve their presentation and communication skills, and coaching on presentations, but also three of the judges indicated they were positively impressed by students' presentations, which was also encouraging to instructors.

Faculty Debrief

The two main instructors for the Integration Lab were given seven questions as guide for their reflections. The questions were related to expectations for the activity, impressions of teamwork dynamics, impressions of the quality of the work provided by student, student engagement during the activity, impressions related to group presentations, including student engagement for the students who were not presenting, and take-aways for the activity. The following paragraphs present the combined reflections of both main instructors for the activity.

Given the transformative nature of the course and that the two instructors for the activity were also course managers for the 9-credit hour new course proposed, selecting the project prompt and reviewing it to fit the needs of the class was difficult, but both were satisfied with the final selection. The focus on a response for qualifications (RFQ) was a natural step to the request

for proposals (RFP) students in the old curriculum are currently doing for their senior capstone course, and it is very likely that the RFP activity will continue as a senior capstone activity after the curriculum transformation is complete. However, fitting the Integration Lab activity into the schedule was a challenge. With so many moving parts, it was hard to define which dates would be available for the instructors to provide the instructional modules needed for the activity. The original intent was for it not to be a project, to not overwhelm the students and provide a low stake activity environment. However, given the timing of the Integration Lab (towards the end of the semester) students were 'burned-out' and were unhappy to work so much in an activity that had such little impact in their final grade.

Both instructors for the activity expected students to buy into the authenticity of the task at hand, including showing professionalism in how they worked in teams. Most students seemed indeed excited to work on something so authentic to the construction industry. This showed in terms of student engagement for the activity. Even though some students have complained about the little points assigned to it, most of them were engaged even during other teams' presentations. Therefore, the instructors believe the project based approach was beneficial to students' learning. However, to be truly a PBL activity, the authors acknowledge that students should have been presented (and made aware) of the Integration Lab prompt much earlier, so they could relate the content presented to them in the other modules of 9-credit hour course even previously to the work they have performed during activity.

The first day of the Integration Lab was interesting. Even though the instructor has given the prompt to students a week in advance, groups were only formed the day before the first small meeting (November 26th) and few students had actually read the RFQ. During the large meeting on November 26th, one of the integration lab instructors brought the RFQ prompt to class and described what the plan for the activity was and how the next week of small group meetings would be. During the first small group meeting on the following day, however, few students have read the document, with most only glancing over it. The finalized prompt was 20 pages, with multiple attachments in addition to the prompt, they included information on the Integration Lab evaluation (rubrics) but also about the client expectations and the site. Given the lack of preparation, students were naturally overwhelmed by the activity during the first small meeting and asked for examples. Because this was a new course, the instructor did not have examples to show them for the exact same activity, but showed them a printed copy of a previous student competition packet and warned the students about not being the same scope. However, it gave them something to base, as most of them had never seen what a RFQ response should look like. However, previous experience of one of the instructors in showing students past examples also indicated that students may have their creativity hindered, so it is important to evaluate how the scaffolding should be provided in the future.

According to the faculty reflections, the quality of work varied a lot, with some groups far excelling expectations and others struggling during the oral presentation, and also for the written report. Most struggled with making effective presentation aids, and grouping information in the written report in a way that is easily identifiable to readers. The same variation in quality was seen during the three instructional modules – while some teams worked collaboratively and

proactively, looking online for references, others required more scaffolding from instructors. In addition, instructors have reflected that the decision to use only two of the three hours of the small groups for presentations was not enough as some of the later groups finished on time, but had less industry feedback on their presentations than did the first groups.

During presentations, it was interesting to see that even students that were not presenting at the moment were engaged in listening to peers' presentations. The instructors question if this is the influence of having industry in class. However, despite the positive of having students paying attention to peers' presentations, instructors hoped for more student participation in the question and answers, which did not happen. Again, this could be an effect of having industry in the classroom, but more incentives and scaffolding for students asking questions to peers may be something instructors could look at in the future.

As take-aways for the future, the instructors would (1) move the activity to become a project, so more points are assigned to it; (2) provide more scaffolding on how to do effective presentations, including maybe requiring them to attend and provide a reflection about senior capstone presentations; (3) dedicate more time to the activity and present it to students earlier in the semester, with more meetings and meetings being more focused and spread out through the semester, in order to really use the project as base for a true PBL approach to the course as a whole; and (4) assign more time for students' presentation so that students do not feel rushed and industry has an adequate amount of time to provide individualize feedback and tips to all groups. Overall, the students' and industry professionals' positive comments are encouraging for future iterations of an improved Integration Lab at the sophomore level.

Lessons Learned and Future Recommendations

As the Spring 2019 semester unfolds, the Integration Lab activity instructors look forward to improving the activity, though only one of the activity instructors for Fall 2018 remains as the 9-credit hour course manager. In addition, given the little time between semesters, some of the reflections take-aways and suggestions made by industry professionals and students may not happen during the 2018-19 academic year.

As we reflect upon the first iteration of the Integration Lab activity, we have the following main lessons learned:

- Authentic tasks are well received by students, however being these sophomore level students, more scaffolding might be necessary as to what are the expectations for professional documents and presentations. More scaffolding my mean showing students more examples (of written material or oral presentations, such as attending the senior capstone presentations), including more instructional modules for the activity, or having more time for rehearsing presentations and showing their written report prior to the final submission;
- Having industry professionals as judges and evaluators of students' work is very well received by students, despite it also increasing their level of stress with the activity. In

addition, clearly orienting professionals to evaluate students, but also provide specific feedback and tips was very well received by students and enriched the learning experience;
- Take into consideration the effects of student 'burn-out' at the end of the semester when assigning points to the activity;
- The proposed Integration Lab activity suits well for a PBL environment, but for students to make full use of a PBL environment, it should be presented earlier in the semester, so students can use the activity as integrator of the different course content.

For the Spring 2019 semester, the authors plan to have a second iteration of the activity, but now as one of the four main course projects, and no longer as a low-stake activity, following students' suggestions. The scheduling aspect of the activity remains a challenge and will have to be dealt in later iterations, as to fully use the Integration Lab in a PBL environment. As recommendations for other programs attempting such activity for sophomore level classes, we suggest that to spend the time to select an authentic activity that meets course objectives, that the instruction (or help sessions) for the activity be spread out through multiple small sessions for more scaffolding, and to include industry professionals if possible, not only to be used as evaluators, but also as consultants to students by providing targeted feedback and general tips for students' future career in the construction industry. In addition, the authors plan to develop a follow-up study with students who have had the Integration Lab activity after their senior semester experience to evaluate if the Integration Lab has helped in their capstone presentations and written document performances.

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