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Leveraging Construction Higher Education to Expose a Broader Audience of Public School Students to the Construction Industry in the United States

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The workforce shortage in construction is a serious issue. With a plethora of initiatives emerging in the past few years to attract more individuals to careers in construction, a question has arisen as to whether the initiatives reach an audience outside of those who would go to work in construction anyway. This project sought to develop an intervention that would expose a broader audience to construction topics, and related careers in construction, through a course in a construction higher education program. Students in the construction higher education program created lesson plans that would be employed in public school classrooms and fit in the required curriculum, thereby reaching all students and not just those already inclided toward a career in construction. The results suggest the course was successful in achieving its initial objectives, however long term impacts on the workforce shortage are not yet known.

Keywords: Recruiting, Outreach, Education,

Background/Introduction

The labor shortage facing the construction industry today is significant and predicted to get worse. In 2014 this crisis for the construction industry began to take center stage and was highlighted by the AGC's national workforce survey (AGC, 2014). That survey validated the complaints of many contractors that it was getting increasingly difficult to find both managers and tradesmen to execute projects. The challenging outlook published by the AGC (2014) and various other studies exploring the workforce shortage (Bigelow, Zarate, Soto, Arenas, Perrenoud, 2018; Hodges and Crowley, 2014; Francis & Prosser, 2012) have brought some attention to this issue, but have by no means solved it.

A more recent report continus to tell the same story. Contractors still can't find the skilled tradesmen needed to execute projects (AGC, 2018). Four years after the 2014 AGC report, that association has moved beyond reporting the problem and is now calling for measures to solve this issue, with the publication of the "AGC Workforce Development Plan 2.0". The AGC isn't the first or only group

that wants solutions, either. As the labor shortage has persisted, various groups have been formed and initiatives undertaken attempting to provide solutions to the workforce shortage, and some have existed for many years but are now receiving additional support and attention.

There is a large and seemingly ever increasing number of organizations devoted to addressing the workforce shortage. Workforce committees from local AGC chapters across the country have created programs to advance the issue, creating programs like: Build California, Build Texas Proud, Go Build Alabama, and Build Colorado, to name a few. These groups have local recognitions and promotion of construction in their regions. They also serve as hubs for information on craft training and job opportunities. Although these programs are regionally focused there are also initiatives on a national scale, The National Center for Construction Education and Research (NCCER) has the Build Your Future program focused on recruitment, training, placement, retention and image enhancement strategies. There is also the I Build America that is a national movement focused on building pride in the construction industry, educating the public about the value of construction and recruiting the next generation of construction professionals. The National Association of Home Builders along with The National Association of the Remodeling Industry, The National Kitchen and Bath Association and others have created The Skilled Labor Fund, an initiative focused on sponsoring scholarships and vocational and technical programs. There is also #KeepCraftAlive, which originates with the publishers of *Fine Home Building*. Like the Skilled Labor Fund, #KeepCraftAlive provides scholarships, but also seeks to promote skilled trades through media. And the AGC has published a national level workforce development plan to specifies how they will support new and existing efforts relating to the shortage.

Beyond these programs dedicated to construction, there also initiatives that seek to advance vocational and technical education in general. The Harbor Freight Tools for Schools and Let's Build It initiatives that provide annual prizes for teaching excellence and is focused on advancing vocational and technical education programs in schools. More broadly is the Mike Rowe Works Foundation and it's S.W.E.A.T. Pledge (Skill & Work Ethic Aren't Taboo) that awards scholarships and seeks to connect individuals with career opportunities that don't require a college education. These initiatives advance construction as just one vocational or technical career path.

The programs listed and described here are not an all-inclusive list of organizations focused on this issue, and although they represent a large number of people dedicated to addressing the workforce shortage, empirical evidence could not be found indicating if or to what extent these initiatives are impacting the workforce shortage. Publications found to date focus on the ramifications of the shortage, the need to address it, and potential solutions (Bigelow et al., 2018; Albattah, M. A., Goodrum, P. M., Taylor, T. R B., 2015; McGraw-Hill Construction, 2012). While this paper does not fill that gap in the body of knowledge it presents a novel approach to addressing the workforce shortage in construction.

Motivation

In the absence of empirical data to support any of the approaches/organizations addressing the workforce shortage, there is no guarantee any of these efforts will alleviate the issue, and the authors assert that a fundamental problem exists with these efforts. Scholarships to students pursuing a career in construction are good, likewise support of vocational and technical schools is sorely needed. Websites promoting the industry and directing candidates to job and training opportunities are also helpful. However, these efforts fail to reach students not already interested in or planning to enter the construction industry. Recruitment efforts must reach a broader audience, and thus bring talent to the construction workforce that may not have otherwise been interested, and thus would have gone

elsewhere. It has been well established that students are unlikely to be directed towards careers in construction, particularly female students (Francis & Prosser, 2012; Koch, Greenan, Newton, 2009; Federle, Rowings, DeVany, 1993), so to reach students who do not know or would not consider a career in construction, different approaches are necessary. Without a broader reach and impact, the workforce shortage in construction is unlikely to ever be remedied

Just as general contractors cannot ignore the shortage of skills workers, higher education should not ignore it either. The workforce shortage directly affects the careers and responsibilities of project engineers, project managers, and superintendents which are the roles most of our graduates assume upon graduation. Unfortunately, how programs of higher education in construction can positively impact the workforce shortage is not readily apparent. This paper describes one effort attempting to resolve the construction workforce shortage. The effort is novel in its intended audience, but also in that it leveraged students in a construction higher education program to produce and test content.

In 2016 The National Association of Home Builders sponsored an RFP for the creation of multiple lesson plans for their members to take into their local schools. These could be taught by a builder or passed to a teacher. The effort was inspired by a project undertaken by the ABC (Associated Builders and Contractors). The NAHB wanted lessons that would: *"Expose students and get them excited about the possibility of a career in construction..... create lesson plans that NAHB members can easily understand and facilitate in 5th-8th grade math and science classrooms locally around the country that promote careers in construction. Real world application of math and science that fits into a regular class period, a lesson plan welcomed by teacher." (NAHB, 2016).* This RFP became the genesis of the construction lesson plans concept. Following the basic mandate of; integrating home building concepts into required curriculum and including a memorable hands on experience, a construction faculty member acted as a subject matter expert and utilized a middle school teacher to develop three age appropriate lesson plans for the NAHB.

The lessons needed some fundamental components. Integral to each lesson were; a direct link to the homebuilding industry, a memorable activity, and a required curricular concept. Use of a professional teacher as a consultant on the project, ensured that these items were included, however the project did not pilot the lessons in a real classroom to learn if students liked them or not. Although a teacher was used to help develop these lessons, their initial impact and effectiveness was unknown. Nevertheless, the NAHB was pleased with the lesson plans produced, and made them available to NAHB members via their website.

In 2018 the NAHB returned to the faculty member to produce additional lesson plans to expand the NAHB library. However, two challenges were identified. First the need to pilot each lessons with real students in a classroom was deemed necessary. Second the faculty member believed that better ideas for activities, that would excite students, would likely come from the students in the construction program. These students were only a few years removed from the 5th-8th grade target of the lesson plans, and could rely on their personal experiences to develop an engaging class.

Based on the idea that a student could come with better ideas for engaging lesson plans, and could be required to also pilot the lessons, an elective course was created.

Methods

In the Spring of 2018 the first iteration of this course was offered and nine students enrolled. Students were required to create two lesson plans each for 5th to 8th grade students. One based on homebuilding (to deliver to the NAHB) and a second one on a construction topic of their choice.

In the Spring of 2019 the course was offered a second time. Enrollment was limited to eight students. This limitation was imposed to provide adequate time for student presentations of their lessons. Again students were required to produce two lesson plans each. One had to be focused on construction trades, while the second could relate to any aspect of construction. In 2019 the lesson plans were contracted by TEXO (the combined AGC and ABC in Dallas & Fort Worth, TX). TEXO changed two things from the first offering of the class. First they wanted lessons for 5th through 11th grade. Second, while the NAHB only wanted electronic materials, for TEXO students would produce a complete "tool box" for the lessons including all visual aids and activity materials.

One additional change occurred between the courses. In the 2018 course the education consultant was engaged after the fact, and because of budgetary constraints only one individual was used. So, the student lesson plans were reviewed by the consultant only when they were complete. In the 2019 course, a larger budget was available and so two education consultants were engaged, and these consultants were involved throughout the development of the lesson plans rather than just at the end.

In both iterations of the course, the organization was generally the same. As can be seen in Table 1., following some initial instruction on 5th-11th grade teaching and required curriculum (common core and state based), the course required students to first give a quick pitch of their lesson idea to the class. From there, students presented a slightly longer formal outline of their lesson, and then each student taught their lesson to the class, before finally going to an actual 5th-11th grade classroom to teach their lesson.

Table 1

Course Calendar and Description

Class Period	Topic	Description
1	Course Expectations	Outline of requirements and goals
2	5th-12th grade teaching and learning	Presentation by teaching consultants
3	5th-12th grade teaching and learning	Presentation by teaching consultants
4	Lesson #1 Idea Pitches	5 min pitches of lesson ideas
5	Lesson #1 Outline Presentations	15 min detailed outline of lesson
6	Lesson #1 Outline Presentations	15 min detailed outline of lesson
7	Lesson #1 Outline Presentations	15 min detailed outline of lesson
8	Lesson #1 Taught to Class	Lesson taught to class
9	Lesson #1 Taught to Class	Lesson taught to class
10	Lesson #1 Taught to Class	Lesson taught to class
11	Lesson #1 Taught to Class	Lesson taught to class
12	Lesson #1 Taught to Class	Lesson taught to class
13	Lesson #1 Taught to Class	Lesson taught to class
14	Float	
15	Lesson #2 Idea Pitches	5 min pitches of lesson ideas
16	Lesson #2 Outline Presentations	15 min detailed outline of lesson
17	Lesson #2 Outline Presentations	15 min detailed outline of lesson
18	Lesson #2 Outline Presentations	15 min detailed outline of lesson
19	Class Canceled Spring Break	
20	Class Canceled Spring Break	
21	Lesson #1 Taught to Class	Lesson taught to class

22	Lesson #1 Taught to Class	Lesson taught to class
23	Lesson #1 Taught to Class	Lesson taught to class
24	Lesson #1 Taught to Class	Lesson taught to class
25	Lesson #1 Taught to Class	Lesson taught to class
26	Lesson #1 Taught to Class	Lesson taught to class
27	Float	
28	Pilot Lesson in Real Classroom	
29	Pilot Lesson in Real Classroom	
30	Pilot Lesson in Real Classroom	
31	Pilot Lesson in Real Classroom	
32	Pilot Lesson in Real Classroom	

The process was highly interactive. At each stage of review (idea pitch, detailed outline, and teaching to the class) students had to gain approval from the instructor, before proceeding to the next step. Additionally, feedback from every student in the room was required. The instructor facilitated this discussion asking each student to give feedback based on what was good and what should be improved in the lesson.

The interaction served two purposes. First, it keeps students who were not presenting a lesson plan engaged in the classes even though there were not tests or other assessment outside of the lesson plans. Second it ensured that each student was tapping into a larger base of knowledge and experience than they held individually.

The final deliverable of the course were the completed lesson plan materials. These included: Typed Lesson Plan, Suggested Script, Handout(s), Activities (with rubric), and visual aids (presentation material). These materials were required in digital and hard copy formats. The final deliverable of the course was for each student to have the teacher, in whose class they taught their lesson, send an email verifying the course was taught and providing feedback on the lesson.

Some of the lesson plans produced through the class are described in Table 2. As can be seen, only 2 high school level lesson plans were developed. The majority were targeted at 5th to 8th grade students.

Table 2

Sample of Lesson Plans Developed

Grade	Subject	Topic	Activity
5th	Science	Electrical Circuit	Assembling and testing an electrical circuit with different resistors and components.
5th	ELA	Construction Process	Card sort of stages in a construction project.
5th	ELA	Collaboration & Communication	Lego construction playing different project roles (Arch, PM, Super, Sub).
5th	Math	Home expenses	Home utility expenses calculation.
5th	Social Studies	Estimating	Use of scales and prices to quantify and estimate cost.
5th-6th	English	Communications	Team cup tower construction project.
5th-6th	Science	Plumbing and Water	Head pressure and water pumps.
6th	Math	Home Construction Costs	Calculating construction costs based on student designs.

6th-7th	Science	Marble rollercoster	Build marble roller coaster from plans and measure time differences with changes.
7th	Social Studies	The Great Wall of China	Mega structure quiz game.
7th	Science	Carpentry	Tool identification. Measuring and marking using tapes and squares. Hammering and sawing optional.
8th	Science	Tech in Construction	Matterport 3-D scavenger hunt.
8th	Career Planning	Construction Trades	Trade identification in a BIM model.
8th	Math	Mechanical Contracting	Measure and calculate BTU load for their classroom.
9th-10th	Geometry	Concrete	Calculate concrete quantities in piers.
10th	Science	Transformers	Measure of electrical current before and after a transformer.

Results

Although a longitudinal study would be required to measure the long term impact of the lesson plans developed on the workforce shortage, assessment of the course and initial impressions of the lesson plans were collected via student evaluations and teacher feedback.

In both iterations of the course, multiple students did not complete and submit the required work. In 2018, three of the nine students enrolled earned incompletes and in 2019, two of the six students earned incompletes. Despite these negative outcomes, student quantitative and qualitative evaluations of the course were strong. Table 3 displays the results of the evaluations for each year. In 2018 seven of the nine students completed an evaluation and in 2019 three of the six students completed an evaluation, resulting in an overall average score of 4.75 out of 5.

Four of the five qualitative comments about the class were positive. These comments indicated: "Great class", "Interesting and engaging course", and "The class was fun…...I really liked it". There was also one emoji, :) given. The one negative comment was: "We shouldn't of had to teach two lessons". The positive comments suggest the class would be well received if offered again.

Table 3. Student Evaluations of the Course

Question	**2018 Score**	**2019 Score**	**Average**
In this course I gained a basic understanding of the subject (e.g. factual knowledge, methods, principles, generalizations, theories).	5	4.667	4.9
In this course I learned to apply course material to improve problem solving.	5	4.333	4.8
In this course I developed skills to express myself orally, graphically or in writing.	5	4.333	4.8
In this course I learned how to find, evaluate, and use resources to explore a topic.	5	4	4.7
In this course I learned to critically evaluate ideas.	5	3.667	4.6
Overall, I rate this course as excellent.	5	4	4.7

Qualitative responses from teachers were positive and provided a bit more context. There were various pieces of positive feedback like how the teacher learned something new from the lesson (what a "triangle ruler" is), and a teacher requesting the lesson plan for future use. However, after coding five themes emerged. The first two themes were positive, but provided little depth by which to gage the course and the lessons plans produced. These two themes were that the students enjoyed the lessons and the students enjoyed having our students teach them. The three more meaningful themes that emerged were: how well prepared/organized the students were, how the lessons kept the students interested/engaged, and requests for our students to return and teach again if possible.

Unfortunately the project did not have permission to directly collect the perceptions of public school students on their opinions of the lessons. Two of the themes that emerged from teachers suggest students liked the lessons (the students enjoyed the lessons and the lessons kept the students interested/engaged), but this is an area that merits future research.

These results suggest that the lesson plans met the goals of the course. The goal of piloting the lessons plans in a real classroom was achieved simply in the execution of the course, however the goal of creating activities in the lessons that would be engaging and memorable appears to have been achieved based on the teacher feedback. Further by being taught in a typical public school classroom, a broader audience of students were exposed to the construction industry and the careers available in it.

Lessons Learned

Although the short term goals of the course appear to have been met, there were some additional lessons learned over the delivery of the course that should be noted.

A Spring semester course is not ideal. Because students cannot teach their lessons in a classroom until after they have gone through the feedback and approval process in class, many students were left with very little time to teach their second lesson plan before the summer (for both college and public schools). In both classes some students were forced to teach their lessons in the subsequent school year. In the 2018 iteration this issue was heightened by a public school teacher's strike that further shortened the public school year.

Feedback from students is not a given. In the interactive process including the idea pitches, outline presentations, and teaching to the class, students in the class would generally not provide constructive criticism. They were more willing to give positive feedback, but a structured process where the instructor called on each student in turn was necessary to draw on the knowledge of the group. Initially this also turned out to be the case with the teaching consultant as well, who at first would only provide positive feedback.

Student feedback is necessary for success. In both classes students consistently attended class and participated (when called on). The instructor told the students at the beginning, when outlining the course, that as long as they attended and participated, quizzes and/or other assignments would not be required. This strategy proved successful. However, if students had stopped attending consistently other assignments or grades would have been necessary to ensure quality feedback was consistently attained.

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