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Pilot Study: Assessing Construction Management Student Knowledge Using Student Learning Outcomes in Construction Internships

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Abstract

Internships or co-operative learning experiences have proven a value for young professionals or students to gain hands-on experience and knowledge in their chosen degree and career path. Companies find value in this process as a process to identify potential candidates that would be suitable to hire as careered paid positions within the company and in many cases provide the opportunity to hire the student prior to their graduation. Construction management academia also finds value through the internship process to help validate the theory disseminated in construction courses. This paper is a pilot study that attempts to understand how the American Council for Construction Education (ACCE) student learning objectives (SLOs) can be used as a framework to identify knowledge being acquired during the summer internship process. Each of the ACCE SLOs are a specific construction management knowledge content area students must know upon their graduation from their chosen University. Through a quasi-experimental process, the researcher collected data using a learning management system (LMS) to group, classify, and assess the areas students are mostly engaged with while actively participating in their internship. Findings from this assessment strategy show the knowledge areas students are mostly engaged with during the internship include the process of creating communications, presentations, safety plans, estimates, and schedules on actual construction projects.

Key Words: Internships, Assessment, Student Learning Objectives, Construction Management

Introduction

Internships or cooperative-learning experiences offer a valuable way for students to engage with industry in their chosen career choice. Typically, the goals of this experience are to allow the student to take their knowledge acquired in academia and apply their knowledge in a real-world scenario or to allow a student who has no experience in their chosen career path to gain experience or "test the waters" to really identify whether the chosen career path is "the right choice." For students, the internship has its purpose, employers have found the internship experience to be a place where they can test and review future employees who may wish to join their companies. Many employers will put the student in multiple situations to test the student within their company to identify if the student would be "the right fit" for their company culture [9]. This requires the employer to expose the student to many different people and job scenarios that occur within the construction company [1].

Literature Review

Historically the idea of an internship stemmed from the trades people of Europe in the 11th and 12th centuries where the master craftsman and tradesman would take young tradesman to work alongside them to learn their chosen trade. With this in mind and through some very specific training came the idea of an apprenticeship system that would train young unskilled boys to skilled tradesman in many different areas of work [7]. As time progressed through the industrial revolution the apprenticeship concept briefly went away or was reduced and led to vocational training to equip workers needed for factory work. During the vocational training apprentices were machinists and carpenters who would receive payment on a predetermined pay scale and at the completion of their apprenticeship would then join their chosen trade or labor union. The idea of an intern first was applied to medical students in the 1920's and in the 1960's internship or co-op programs were offered on college campuses as a way to integrate the college bound student into the mainstream workforce [1]. The literature has also suggested the terms of service learning, cooperative education, cooperative learning and internships have all been defined to "designate the student experiential learning outside the university setting, with the goal of preparing students for successful entrance into their chosen field" [15], [16].

For construction management, the concept of an internship is the process of providing the student exposure to the professional side of the construction industry while applying their education in a hands-on manner. This process has become a very important component within many construction management programs [3], [12]. Construction management internships are a three-way partnership with the university, industry and student [12], [13], [15]. Previous research on internships studied the perceptions in the benefits of employers sponsoring a student construction management intern and their expectations of intern performance within the internship program structure. What was identified in this research was that "careful attention must be made in balancing the needs of academia with those of industry to build lasting partnerships and provide for on-going internship placements" [12], [13].

Adcox [3] provided a framework for the identification of internship expectations and specific competencies that would be acquired during an internship. His research provided a framework for the collection, analysis and synthesis of information a student would perform during the internship as a structured course. His collection of information in the course was categorized in six main areas of observation, participation, managing, self-analysis of work effort, outside work activities and a professional development plan. Adcox [3] developed a system where the specified tasks and artifacts could be measured to gain an understanding on construction concepts that were acquired by the students in an applied construction management setting using the internship as the course. This approach helps provide an example on how activity based, evidence-based or problem-based learning can be used in construction management as a rigorous structured approach to acquire structured knowledge based on research and experience as a means to learn [6]. For students to engage in an internship, this allows the student to research construction management related concept and learn construction management competencies and concepts through experiential learning during the internship.

Wasserman [16] developed a study linking the American Council for Construction Education (ACCE) outcomes to measure students' opinion of their own readiness to enter the industry.

Results from the 34 survey responses suggested that students had a high level of confidence in safety, construction graphics and estimating, and low levels of understanding in scheduling, cost accounting and design theory during their internships. He also suggested that the participants found the most significant useful construction skills that applied to the students' career included safety, project management and construction graphics as career skills necessary to enter the construction industry by the respondents.

Internship Programs

In academia, there are many different approaches to providing an internship experience for the students. There are some construction management programs that have a formalized internship program where students are required to intern at a company for a specified number of hours. Other universities may offer an un-structured internship program where the students intern with a company as an elective class. At XX University, the internship program is un-structured, but, students are required to have some type of "construction related experience" for entry into the professional side of the program.

Bloom's Taxonomy

Blooms taxonomy is widely used in educational environments to categorize the levels of learning students acquire while engaged in particular curriculum. Student Learning Outcomes (SLOs) are commonly used to define specific elements students will learn that are tied to an outcomes-based assessment process. These SLOs are important because the define the skills and abilities students acquire while learning their specific educational elements that are achieved for deeper learning and the transfer of knowledge within a curriculum. It has been noted that the most common use of Bloom's taxonomy focuses on "cognitive learning skills rather than the psychomotor and affective skills". In construction, this is the ability for a student to perform a survey layout to establish control on a jobsite and understand the economic effects of costs on materials. Through an outcomes-based approach in construction, educators typically would prefer to see students demonstrate higher levels of thinking and use problem solving techniques commonly found in the field element of construction management. [2]

Bloom's taxonomy uses six categories of cognitive learning skills ranging from lower-order skills to a higher order of skills that require a deeper level of learning. The figure below shows the different categories and levels of lower to higher levels of learning that are commonly used to develop SLOs. [5]

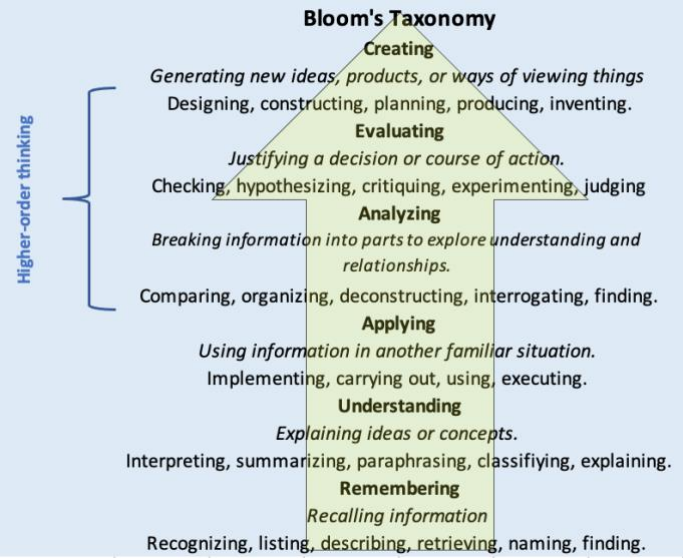

Figure 1: B*loom's Taxonomy* [5]

American Council for Construction Education (ACCE) Student Learning Outcomes (SLOs)

All construction management programs accredited under the American Council for Construction Education (ACCE) must assess their programs using an outcomes-based approach with 20 student learning outcomes (SLOs). Each SLO is evaluated based on a minimum of two assessment methods, at least one of which must be a direct assessment showing evidence of student learning in the form of a student product or performance that can be evaluated. A second method of evaluation for each SLO is through an indirect assessment, which must be evidence of student learning where the learning is a perception, opinion, or attitude of the student or others. Table 1 below shows each of the twenty SLOs and their definitions [2]:

Table 1

ACCE Student Learning Outcomes (SLOs)

Slo #	Student learning outcome
1.	Create written communications appropriate to the construction discipline.
2.	Create oral presentations appropriate to the construction discipline.
3.	Create a construction project safety plan.
4.	Create construction project cost estimates.
5.	Create construction project schedules.
6.	Analyze professional decisions based on ethical principles.
7.	Analyze construction documents for planning and management of construction processes.
8.	Analyze methods, materials, and equipment used to construct projects.
9.	Apply construction management skills as a member of a multi-disciplinary team.
10.	Apply electronic-based technology to manage the construction process.
11.	Apply basic surveying techniques for construction layout and control.
12.	Understand different methods of project delivery and the roles and responsibilities of all constituencies involved in the design and construction process.
13.	Understand construction risk management.

14. Understand construction accounting and cost control.
15. Understand construction quality assurance and control.
16. Understand construction project control processes.
17. Understand the legal implications of contract, common, and regulatory law to manage a construction project.
18. Understand the basic principles of sustainable construction.
19. Understand the basic principles of structural behavior.
20. Understand the basic principles of mechanical, electrical and piping systems.

[4]

Student Internship Expectations

At Central Washington University (CWU) students can earn credit to be applied to their construction management degree through a cooperative experience class. For a student to register for their cooperative experience, each student must complete a cooperative learning agreement. This agreement is a form acknowledges the completion of sexual harassment training and purchase of liability insurance. The form also acquires the necessary student, employer, emergency contact and faculty information with signatures for approval. In addition to basic information, an academic learning plan is established with each student and employer which includes the internship description, learning objectives and activities. This form serves as the formal contract and syllabus for the cooperative experience. Below are examples of learning objectives and activities that are tied to the internship description and goals:

- Develop an understanding of *drawings and specifications* related to the interns assigned project(s). Write a report (5-10 pages, double spaced) explaining how the intern used drawings, specifications and what the intern learned during the internship. Be sure to discuss daily activities, accomplishments, and attendance at company trainings during the internship.
- Submit a *weekly log* of activities to Canvas which include tracking of construction quantities, engineering duties, labor, material, and equipment. This can be in the form of a word document each week, include pictures into the document to be uploaded to the learning management software for the week.
- Take *daily photos* of various critical activities occurring on the project and submit to Canvas.
- Acquire internship documents (Internship Artifacts) to demonstrate the different types of documentation used during the construction process and submit to Canvas.
- *Presentation* of experience acquired during the internship to a class. A complete power point presentation will be uploaded to Canvas prior to the end of the internship.
- Complete eight (8) Construction Perspectives documenting experience gained in twenty (20) subject areas associated with the American Council for Construction Education (ACCE) Student Learning Outcomes as they are related to the internship experience.
- Canvas will serve as the professional portfolio. All items including the daily log of activities, samples of internship documents (Internship Artifacts), daily photos, written shall be uploaded for review by the internship faculty member.

Methodology

This research associated with assessing construction management student knowledge using student learning outcomes employed a qualitative meta-analysis process to identify the knowledge gained within the ACCE twenty student learning outcomes associated with a field internship. The researcher used the journal entries from the construction perspectives to document the experience gained within the twenty student learning outcomes as students reported their experiences under each subject area. As Glass [10] explains, meta-analysis is the "the statistical analysis of a large collection of analysis results from individual observations or studies for the purpose of integrating the findings". The methodology for this research will use the discussion entries of construction management student perspectives as entered in a learning management system, in their words, while on their internships. The data will provide a broader context as to the common themes on what students are learning and emerge while participating in the internship process associated with the ACCE twenty (20) student learning outcomes. Journal entries within the Canvas Learning Management system have been used to collect the data for analysis. This methodology will attempt to answer the following questions.

1. What are the common core themes that emerge from a student perspective as they relate to ACCE's twenty (20) student learning outcomes?
2. How is the construction internship categorized as related to Bloom's taxonomy on creating, evaluating, analyzing, applying, understanding, and remembering?

Qualitative meta-analysis uses an exploratory research process. Routio [14] explains that the researcher starts with a vague idea of the notion of the project and through the exploratory research process, develops a clearer picture of ideas and concepts through the exploratory research process. Cooper and Schindler [8] state that "through exploration researchers develop concepts more clearly, establish priorities, develop operational definitions, and improve the final design" as studies are developed (p. 139). They also argue that "while published data are valuable resource, it is seldom that more than a fraction of the existing knowledge in a field is put into writing" (p. 141). Hence, this research will attempt seek information about what students are learning as it relates to the SLOs and attempt to categorize the perspectives of what students are learning during an internship within Bloom's taxonomy.

Students were asked within the student learning management system to reflect on several guided questions as they relate to the SLOs. The following list of questions were used to identify the data as it related to the SLOs as identified within eight different modules. Each of the specific questions are specific to Bloom's taxonomy and follow a sequence of deeper learning as the students progress through their internships during an eight-week period. The questions posed to students within the learning management system are as follows:

1. What written communication have you created during the internship that is appropriate to the construction discipline.
2. What oral presentations have you created that are appropriate to the construction discipline?
3. Have you created a construction safety plan? To help inform this question, what was the type of plan (overall jobsite, task specific plan, trade specific).

4. Have you created a construction cost estimate? Describe the type of estimate and define. What type of estimate, detailed, trade specific, conceptual, overall project estimate?
5. Have you created a construction schedule? Describe the type of schedule and define. What type of schedule, short term look-ahead, overall project schedule, or simple schedule?
6. What professional ethical decisions have you made thus far? If one decision stands out, explain and elaborate.
7. Provide an analysis of the types of construction documents used for planning and management of the construction process.
8. Provide an analysis of the methods, materials, and equipment you have observed that are used to construct projects.
9. What construction management skills have you most used as a member of a multi-disciplinary team? Multi-disciplinary as defined as working with architects, engineers, construction managers, laborers, foreman, etc.
10. List the electronic based technology applied during your internship. Pick one and elaborate on how this technology provided efficiency for your current position.
11. Explain the basic surveying techniques you have applied for the layout and control of a job. (Ex. If you have used drone footage to control quantities, explain.)
12. What project delivery method is being used on your current project and identify/explain the roles and responsibilities of all constituencies involved in the design and construction process.
13. Describe your understanding on how risk management is managed by the architect/engineer, owner, and contractor for the project(s) you are involved with.
14. Explain how construction accounting and cost control are managed on your project.
15. Explain the systems that are used to assure construction quality assurance and control on your project.
16. Explain your understanding of the construction project controls process used on your current project? Project controls is simply defined as the systems put in place to monitor the project status from planning, construction, and closeout of the project. Each response may be at a different stage depending on the position of the intern. Therefore, responses will vary which is OK.
17. Explain your understanding of the contract as it pertains to the management of the project(s) you are on with your internship.
18. Explain the basic principles of sustainable and/or environmental principles being utilized on your job.
19. What basic principles of structural behavior have you participated in, discussed or observed during the course of your internship? Structural behavior can be applied to the methods and materials being used with soils, structural steel, framing, concrete, wood structures etc.

20. During your internship, explain some of the basic mechanical, electrical, and piping systems you have become familiar with related to the construction management curriculum.

Limitations

As with any research there are limitations with any study. Many of the entries into the journal using the discussions board where only provided as a guide. Students were provided little instruction on what to incorporate in their entries, therefore their entries are from their own experiences and seen through their understanding of the SLOs. The study was also limited to students under one instructor and the time duration to collect the data was only within an eight week stretch. Additionally, over fifty (50%) of the students who participate in the internship are within their third year or junior year of their education process at XXU. Therefore, their experience range varies widely from some students who have no construction experience to those who are very experienced with several years of physical construction experience.

Results

All the data was categorized based on key word findings associated with each of the SLO questions. Data was collected based on the key elements as they relate to the SLOs and how students perceived their experience as journalized within their guided construction discussion boards. A priority was placed through a manual process to identify the frequency of each of the items shown below to indicate their significance within the discussions students posted. As mentioned, the discussions were reflections of what the students have experienced as it related to their internship associated with the SLOs.

Table 2: SLO Themes

Field Management/Experience	Office Experience
Survey Techniques	Cost Estimates
Reading Documents	RFIs
Written communications	Project Schedules
Oral Communications	Sustainable Construction
Project Safety Plans	Contract Law
Construction Documents	Accounting & Cost Control
Quality Assurance and Control	Risk Management
Project Controls	Project Delivery
Cost Controls	Structural Behavior
Ethical Decisions	
Electronic Based Technology	

As shown above the results varied with respect to the level of significance for each SLO. Most importantly what is shown are the common core themes students associated with each of the SLOs within their discussions in how the SLOs related to either field management or experience and office related experience. For a single class there were eighteen (18) students commenting on each discussion question during the summer internship which defined the themes shown

above. When the results were analyzed assumptions for normality, linear relationships between pairs of variables, and variables' being correlated at a moderated level were checked. The two factors of the field and office relationships were checked and the most prevalent factor that emerged was the field management to define what students are learning during their internships.

A factor analysis was performed to confirm the theoretical factors and find communalities to determine which factors would be correlated. Therefore, a principle axis factor analysis with a varimax rotation was conducted to assess the underlying structure for three hundred sixty (360) items which included the eighteen students with twenty discussion entries associated with their internships that related to the twenty (20) SLOs as they relate to Bloom's taxonomy.

Table 3: Factor Loadings from the Principle Axis Factor Analysis with Varimax Rotation for a Three-Factor Solution for SLOs (N = 360)

Item	Factor Loading			
	1	2	3	Communality
Communications			.499	.730
Presentations			.307	.795
Ethical Decisions			.356	.935
Estimating	.361		.453	.756
Documents	.697			.905
Mechanical Systems	.353	-.588		.749
Team Skills	.413	.497		.784
Safety Plans	.450	.480		.672
Estimates	.498			.868
Schedules	.514		-.567	.875
Methods	.464		.363	.861
Surveying	.498	.332	-.445	.842
Cost Control		.416		.898
Delivery Roles	.312	-.467		.896
Sustainable Const.	.491			.820
Quality Control	.591			.753
Technology	.434			.904
Risk Management	.453	.525		.779

Note: Loading <0.30 are omitted. Not all items are shown.

These clustered factors represent the items that show the most communality related to the each of the SLOs. The items that show a higher loading greater than 0.40 (>0.4) were used to reduce the total number of items to be analyzed in this study. Items with the higher loadings within their respective theoretical associations were used to be recoded due to consolidate and explain their association with the SLOs as they relate to Bloom's Taxonomy from the intern's perspective. Table 3 shows the items from the exploratory factor analysis process that the researcher used to determine the communalities of the different SLOs. It can be observed that the most significant items that emerged through the factor loadings included technology and document reading. Additionally, many of the higher loadings shown within the communalities What can be

identified by this information is the fact that those items that had a higher loading were related to creating and analyzing associated with Bloom's Taxonomy.

The loadings were determined based on the researchers review of the response to the question being posed. As the reviewer would read the passage each passage was rated on a value from one (1) to five (5). Therefore, when a student provided a reflection, if the reflection keyed in on several of the Bloom's Taxonomy items, then each item, whether it was creating, evaluating, analyzing, applying, understanding, or remembering would get a factor rating based on the subject area and its relationship to the Bloom's taxonomy categories. To understand this more fully, the response shown below was categorized as a five (5) based on how the student responded to the question.

> I was able to view and observe an oral presentation within my first week of my internship. The third Thursday of every month there is a Project Engineer training presentation, where a group of PEs will write up a presentation about something going on at their project. The presentation I observed they discussed Building Enclosure and Waterproofing. This topic was discussed because it can be a very difficult part of construction. They weren't afraid to discuss of some of the issues that happened on previous projects with this particular subject in construction. It isn't an easy task to accomplish because there are so many different ways to perform this job. I believe this oral presentation was a way to communicate to others some tips to help others from their failures. I would consider this presentation was informative and was used to instruct the audience to help them understand a very complicated topic.

While the student did not actually create the presentation, they observed several key presentations which provided a medium rating of around three (3) for this observation, since the student did not perform the presentation but observed more seasoned professional who have made and presented construction related presentations. The reflection would have been rated higher at five (5) if the student had stated "I created a construction oral presentation on...". If the student did indicate that they did not create a construction oral presentation, then they would simply get a zero (0). This does explain the relatively low rating for presentations as shown in the data to be at a level of .795 for the communality score. This question was posed to the student early in their internship, most likely the student did perform an oral presentation later in their internship. What this does show is that the student through their reflection has a common understanding on what to expect for an oral presentation that must be created within the construction discipline. It also points to the fact that while students are in construction internships, they are being exposed to many of the SLOs and they can be observed performing these tasks. As for the relationship to Blooms Taxonomy, this statement was rated very high within the taxonomy scale as "Understanding" only due to the timing of when the question was presented in the students' internship cycle.

What can be understood with respect to the factor loading and communality scores is that the higher the value for communality shows there was additional emphasis by how the student reported their participation and engagement within a certain subject area. For example, the factor loading for "documents" at .697 with a communality of .905 shows there were several students

who experienced greater hands-on applications in learning how to read and interpret construction documents throughout their internship. The communality score of .905 shows that there was a significant relationship to the fact that students experienced greater learning of how to read and interpret construction documents. With the communality score of .905, this shows the relationship to the student learning outcome (SLO) - Analyze construction documents for planning and management of construction process as showing a significant relationship to this SLO within the Blooms Taxonomy hierarchy during the internship process.

Discussion and Conclusion

This research provided an opportunity to use student observations as they relate to the twenty (20) ACCE SLOs and Blooms Taxonomy to determine the type of experience students are receiving while participating in an internship course. What the exploratory factor analysis process provided was an understanding of what students are observing and experiencing as a construction management intern. It was shown that the value students bring to the internship is the fact that they spend much of their time creating and analyzing within the different concepts related to the twenty (SLOs). Some of the anecdotal comments students made within their discussions were that they spent much of their time working with technology to create management level reports necessary to make decisions by management. Additionally, common themes that emerged were that they spent much of their time creating, analyzing, and applying skills associated with using technology to develop written communications, estimates, construction documents, and schedules commonly used on construction sites.

While there were limitations to this study, there are always improvements that can be made to make the study and the delivery in how the data is acquired to make this study more robust in future presentations of the data. To help support the qualitative answers provided by the students within their journal entries, it would help to have a short Likert scale survey that would help support the qualitative claims made by the students about their observations within the different subject areas. Additionally, it would help to provide better descriptions in the directions to guide students on what they may or should be observing to address each SLO subject area so the student could present their information with better precision to home in on what is to be exposed and understood from the data collection. Another aspect of generating rich content within the study is the delivery or timing of the questions that were posed and when the questions were due. Since some of the questions were posed early in the internship, the students' may not have had the opportunity to perform work related to the questions. But if the student did not have insight to the question posed, they would turn the response around and tie a similar action to the question being asked.

Through student observations and written journal entries, students did indicate that they become quite knowledgeable within their intern discipline through their rich discussions and construction terminology as they explain how the questions relate to them in the internship. Below are sample quotes from a student journal entry showing the level of detail students would include in their descriptions:

- **Understand construction accounting and cost control:** Up to this point in my internship I have not dealt much with construction accounting or cost control, but I have

worked with schedule of values and pay applications. My project engineer manages all vertical transportation (elevators, escalators, and stair), and so he had me review the schedule of values and pay application that the elevator subcontractor had submitted for the past month to verify progress and ensure they aren't paid for work they haven't yet completed.

- **Create construction project schedules:** I did create a short-term schedule based off of our current production rate of hammering through the rock we are currently stuck on. Based off of the first two weeks we have been averaging 60 feet of pipe in an 8-hour day due to all of the rock we have had to hammer through. With this I just came up with a short-term schedule for the week of what points and laterals to work on for different days so that we did not slow down our mainline pipe. This schedule set it so that by Tuesday we should reach manhole #3. We did all of our laterals on Thursday since we knew we were going to be down an operator. When we did the laterals, we also schedule our trucks to only be there for half of the day so that the pipe could be laid without having trucks waiting around wasting money during that task.
- **Analyze professional decisions based on ethical principles:** I haven't made any decisions on my own, but I have been apart of some decisions and I was able to put my input into the decision process. The owners of the project have been going back and forth on creating a stair mock-up or not. After a few weeks they came back to us and said "we want you to decide if it's worth it." With my PM, Superintendent, and Assistant Super, we decided that the mock-up would more than likely be a waste of money.

This research sheds some light on the potential to use the internship process to determine the types of learning that takes place during a student internship. What should also be taken away from this is the typical comment that students make while participating in their internships that “I learned more in the field as opposed to the classroom.” Again, this research shows that while this may be true, students are taking many of the concepts taught in the classroom and they are applying them in a field setting. This is important because this shows that students, while they are interns, bring value to the construction process and are able to apply their skills in a real-world setting.

Additionally, this research data shows the significance and how the SLOs and Blooms Taxonomy are related. More specifically towards construction management internships, the information provides a guide as to the skillsets that are necessary for students entering into a construction management internship. Where we can use this information programmatically and within curriculum development is how and where a student may take a particular class within the curriculum in preparation for the internship process. Therefore, the structure of the construction curriculum within the program could also inform educators and employers as to how prepared students will be as they enter their internship or a final career placement.

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