

Curriculum Framework Development: A Case Study of Implementing a Construction Management Roofing Course

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The U.S. construction industry is currently facing the significant challenge of a declining workforce. Studies of age-related demographics show that the construction industry will not be able to meet its future workforce demands. The roofing industry, one of the essential sectors within construction, faces a similar workforce challenge, presenting a need to build a platform to prepare the next generation of leaders within the industry. With this in mind, the objective of this study was to develop a curriculum framework for a three-credit course (not currently offered in the curriculum) on roofing at the undergraduate and graduate level. An industry-wide survey was developed and distributed to understand the industry's perception regarding current workforce challenges and the perceived need for a course at the higher education level. The study further provides details on the involvement of industry professionals in the course development and implementation, the impact of the course on student's learning and their perception regarding the roofing industry. The findings of the study addressed a current curriculum gap within construction management. The students indicated that they had significantly increased their knowledge about roofing and had generated an interest to explore career options in roofing.

Keywords: Roofing, Construction, Workforce, Industry Involvement, Course Design

Introduction

A declining workforce is a significant concern within the construction industry today (Albattah et al. 2015; Bigelow et al. 2019). Due to the demanding environment (Karakhan et al. 2020) and the increase in generational diversity (Legas and Sims 2011), the construction industry is in continuous development of current and future generations of workforce. O'Lawrence and Martinez (2009) suggest that developing the next generation of leaders must be addressed at all three levels (global, federal, and local levels) for sustaining the US economy. Baby boomers begin turning 65 in the year 2020 and this poses a major challenge for the construction industry at both the craft and the management level. According to the National Center for Construction and Education Research, 41% of the workforce will retire by year 2031 (Bonilla et al. 2019). Multiple efforts are in place to address workforce development at the skilled craft level for various trades (Francis and Prosser 2013; Oke et al. 2017; Sokas et al. 2019; Albattah et al. 2019; Lee et al. 2020; Kim 2020), however, developing the next generation of leaders for management positions within various trade sectors remains to be explored. It is also necessary to have informed and well-educated management personnel to attract and retain skilled craft workers.

One important aspect of developing the next generation of leaders is workforce planning, which involves a continuous process to ensure the organizational needs are being met by the workforce

(Ahmadian et al. 2018). In 2019, a survey conducted by the Associated General Contractors of America reported that 88% of contractors had difficulty finding employees for craft positions. The survey also reported that only 6% of the surveyed companies were able to hire managerial positions without any difficulty (Associated General Contractors 2019). Chaluvadi (2017) also concluded that the lack of skilled labor is a significant problem for 82% of the surveyed builders. The shortage of workforce and skill gap is attributed to the low attraction among the younger generation into the construction industry (Torku et al. 2019). Hence, in order to motivate the workforce towards professional growth and skill development, investing in educating today's youth is key for workforce attraction, satisfaction and high retention rates (Hyari et al. 2010; Ayodele et al. 2020). A well-educated workforce comes from the next generation of leaders that possess skills to respond continually to technical innovations in the construction industry (Dulaimi 2005).

Within construction, roofing is one of the essential trades that involves installation of different roof systems as part of the building envelope. Without the correct installation of those roof systems, the assets within the building, such as property and people, are at risk due to the possibility of roof system failure (Shafique et al. 2018). A well-educated and skilled workforce that can manage and install a quality roofing system is critical for the efficient functioning of a building. The three main primary sectors within the roofing industry include:

1. Manufacturing of roofing materials by building material manufacturers
2. Distribution of the materials from the roofing material manufacturer to the roofing contractor for installation, performed by wholesale distributors
3. Installation of the roofing materials performed by roofing contractors.

In the most recent study available, the roofing industry represented about 8 percent of the overall construction industry workforce (Fredericks et al. 2005). Like general contractors and other sub-contractors, the roofing industry sector is also suffering from critical workforce problems pertaining to labor shortage at both management and skilled craft positions (Choi et al. 2018). Karatas (2019) suggests that only 15 percent of all employees in the roofing industry are 24 or younger and almost half of the employees are between 35 and 54 years old. Moreover, employment trends show a surplus of openings for workforce in the roofing industry (Albattah et al. 2019). Although development in roofing technology (e.g., drones) has decreased the number of workers required for roof installation, the complexities associated with each project still require an educated and trained workforce (Baskaran et al. 2007; Bouafif et al. 2018).

To address this workforce challenge, it is important that the younger generations are educated about the roofing industry at the higher education level (Farrow 2011). Similar to general contractors, Bigelow et al. (2019) discovered that the sub-contractors in the construction industry have also started recruiting from higher education institutions. The accrediting body, Accreditation for Construction Education (ACCE), provides accreditation for construction management schools in the US and has outlined twenty student learning objectives (SLO's) that higher education institutions need to meet. Teijeiro et al. (2013) suggest that curriculum within a construction management or engineering program should be assessed periodically to ensure relevance to avoid discrepancies between academic competencies and industry needs. It was discovered that the roofing industry was one such sector that experienced this discrepancy.

In response, there was a need to develop a course specific to the roofing sector at the higher education level to educate students about the roofing industry and to develop the next generation of leaders for management positions. As a result, the objective of this study was to develop and implement a curriculum for a new three-credit course (not currently offered in the curriculum) specifically on roofing by using the expertise of professionals in the roofing industry. Previous studies have shown that coursework developed with an active involvement of the industry has a positive effect on student learning (Sharma and Sriraram 2012; Zhao et al. 2015). A significant part of this study was also to measure the impact of the course through student perception surveys.

Methodology

The research methodology for this study is shown in Figure 1.

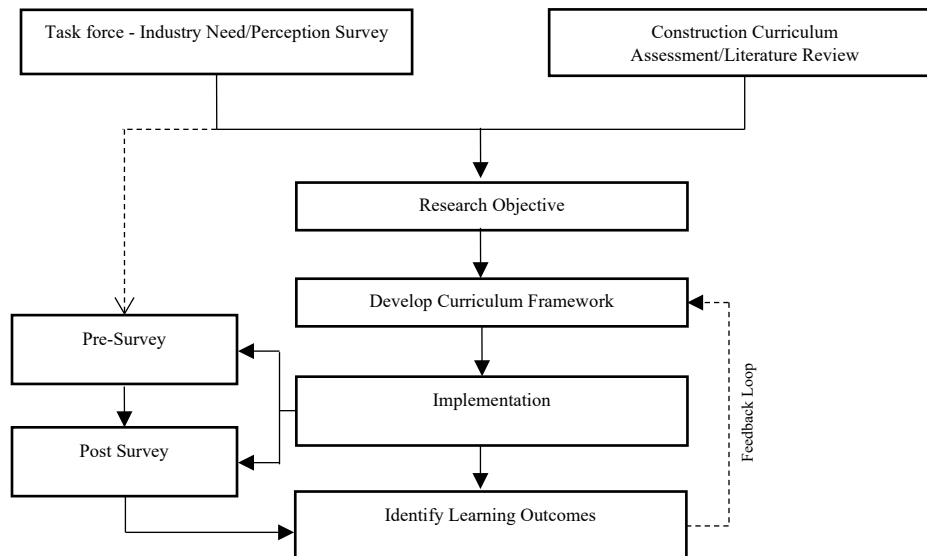


Figure 1: Study Methodology

Based on the literature review and the current construction curriculum assessment, it was determined that there is a need for the roofing sector course at the higher education level.

Industry Need / Perception Survey

This phase included the development and distribution of the initial survey to assess the roofing industry professionals' perception of developing a new roofing course at the higher education level. As part of this phase, a task force of nine industry professionals was created to provide industry expertise, offer feedback and offer key suggestions on developing the curriculum and implementation of the course. Each of the industry's key sectors (contractor, manufacturer, and distributor) was represented on this task force.

The initial industry perception survey was developed jointly by the researchers and the task force. The main components of the industry perception survey were:

1. Professional's background information
2. Professional's view on the current state of roofing workforce
3. Professional's view on offering a roofing specific course at the higher education level
4. Professional's view on providing employment opportunities in the roofing industry for those that have formal roofing education in an academic setting.

The survey was distributed using Qualtrics to 400 roofing professionals by accessing the membership organizations such as, Roofing Alliance and National Roofing Contractors Association (NRCA). A total of 167 responses (42%) were received, as shown in Table 1. Others included consultants, insurance carriers, law firms and technology/software providers.

Table 1: Company Background

Company Background	Data	Percent
Roofing Contractor	124	74%
Roofing Manufacturer	19	11%
Roofing Distributor	6	4%
Others	18	11%
Total	167	100%

Research Objective

Based on the literature review and the industry perception survey, the following aims were determined for this study.

1. Develop a framework for the curriculum of a three-credit roofing course using the expertise of roofing industry professionals.
2. Identify and rank the key topics to be included in the course.
3. Implement a three-credit roofing course.
4. Measure the difference in student's perception about the roofing industry prior to and after the course offering.
5. Provide a framework for developing other trade-specific courses for the undergraduate and graduate levels for higher education.

Develop Curriculum Framework

Since the roofing industry is such a diverse and specialized field with multiple types of roofing systems, one of the challenges of developing a curriculum framework was to understand the type of content and the concepts that were necessary to be included as part of this roofing course. Hence, a second survey was developed and distributed to the roofing professionals for their input and feedback on the topics that must be covered in the roofing course, with a special emphasis on the specific skillsets required of a college graduate before entering the roofing workforce. The involvement of industry partners in updating the curriculum helped in incorporating the concepts

that are needed from an industry perspective (Laguador and Ramos, 2014). A second survey was also developed jointly by the researchers and the task force.

Prior to full distribution, a pilot survey was conducted with the task force members to verify the clarity of the questions and the survey responses. Feedback from the pilot study included adding specific topics to be covered in the course: career options in roofing, understanding roof specifications, roof estimating, and business management.

The main components of the final curriculum development survey were:

1. Professional's background information
 - a. Contact information.
 - b. Type of company (contractor, manufacturer, distributor or other)
 - c. Roof system specialization (low-slope, steep-slope or both)
2. Ranking of top ten out of the twenty topics that the professionals deemed appropriate to be covered in the course. Topics that are relevant to each scope of work are also shown (Contractor – C; Manufacturer – M, Distributor – D).
 - a. Types and Installation Details of Roofing Systems (C, M)
 - b. Building Envelope Systems (C, M)
 - c. Building Function (C, M)
 - d. Building Codes in Roofing (C, M)
 - e. Installation Details of Roof Components (C, M)
 - f. Reading Roofing Blueprints and Specifications (C, M, D)
 - g. Roof Estimating (C, M)
 - h. Roof Scheduling (C, M, D)
 - i. Roof Safety (C, M, D)
 - j. Communication (C, M, D)
 - k. Site Logistics (C, M, D)
 - l. Roof Repair and Maintenance (C, M)
 - m. Finance (C, M, D)
 - n. Roof Procurement / Sourcing (C, M, D)
 - o. Managing Roofing Business (C, M, D)
 - p. Field Crew Management (C)
 - q. Career Options in Roofing (C, M, D)
 - r. Manufacturing and Distribution Channels
 - s. The Roofing Industry and the Environment (C, M)
 - t. Technology in Roofing (C, M, D)
3. Professional's availability in course assistance
 - a. Product Donations
 - b. Content donations
 - c. Guest lectures

The survey was distributed using Qualtrics to 167 participants that responded to the industry perception survey. The key concepts to be covered in the roofing course were selected by ranking the top ten topics from each sector: contractors, manufacturers, and distributors. The topics that were listed as top ten by all three entities were selected to be included in the roofing

course. Based on this topic ranking, a final syllabus schedule was developed, as shown in Appendix A.

Implementation

Based on the development of the curriculum, the roofing course was offered to both undergraduate and graduate students. A total of 21 students (11 undergraduate and 10 graduate) enrolled in this roofing sector course as shown in Figure 2. Two students (9.5%) were civil engineering majors (one undergraduate and one graduate), while nineteen were construction management majors.

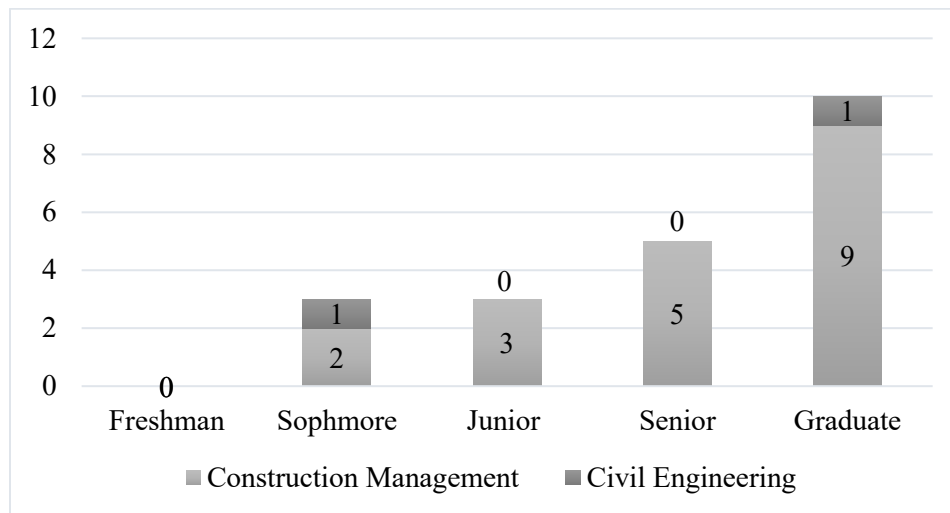


Figure 2: Student Background

Based on the input and feedback from the task force members and due to the involvement of the roofing industry professionals as guest lecturers, the course had the following characteristics:

1. Offered one day of the week for 2.5 hours
2. Class section evenly split between guest lectures and critical thinking in-class assignment
3. Weekly quizzes based on the covered concepts
4. Two exams: mid-term exam and final exam
5. Semester project
 - a. Undergraduate: Roofing Professional Interview and Report
 - b. Graduate: Compile Qualifications Package for a Roofing Project

One of the important components of this phase was understanding the impact of this course on student's learning and their perception about the roofing industry. To that end, pre (at the beginning of the semester) and post (at the end of the semester) perception surveys were distributed to both undergraduate and graduate sections to assess their perception about the roofing industry.

The main components of the pre-and post-survey is outlined in Table 2. A comparative analysis between preferred aspects and the perception questions of pre-and post-surveys were performed.

Table 2: Perception Survey

Survey Component	Pre-Survey	Post-Survey	Comparative Analysis
Student Background	X	X	
Preferred Aspects	X	X	X
Overall Learning		X	
Overall Satisfaction		X	
Perception Questions	X	X	X

Analysis

The analysis for this study was performed in three sections: industry survey, curriculum development and course implementation.

Industry Survey

A total of 167 roofing industry professionals (out of 400) responded to the initial industry survey. Table 3 outlines the results of the survey.

Table 3: Industry Perception

Statement	Strongly Disagree		Disagree		Neither		Agree		Strongly Agree		Weighted Average
	#	%	#	%	#	%	#	%	#	%	
Lack of workforce is a major challenge in the roofing industry today.	9	5%	1	1%	4	2%	18	11%	135	81%	4.61
University graduates lack the basic knowledge regarding the roofing industry.	4	2%	4	2%	9	5%	41	25%	109	65%	4.48
Educating university students about the roofing industry can help tackle workforce issues.	4	2%	12	7%	19	11%	53	32%	79	52%	4.14
University programs should include roofing course as part of the curriculum.	3	2%	5	3%	12	7%	43	26%	101	60%	4.43

The initial industry survey showed that 92% of survey respondents either strongly agreed or agreed that the lack of workforce is a major challenge in the roofing industry. The survey results validated the initial findings in the literature that workforce development within the roofing industry was a major challenge. 84% of the industry participants also either strongly agreed or agreed that university graduates lack basic knowledge regarding the roofing industry. 84% of survey respondents strongly agreed or agreed that educating university students about the roofing industry could help tackle workforce issues (attracting next generation of leaders) and 86% of the industry participants strongly agreed or agreed that university programs should include a roofing course as part of their curriculum.

Also, 156 out of 167 (93.4%) industry participants responded that they were more likely to provide employment opportunities for students with some type of formal roofing education in an academic setting. Hence, the survey findings, along with the existing literature, suggest a need for a roofing specific course at the higher education level.

Curriculum Framework Development

The topics covered in the course must address the current industry needs, and therefore, a survey was developed and distributed to the roofing industry professionals to identify key topics. The initial list of twenty topics within the roofing industry was generated based on input from the task force members in the pilot phase. Figure 3 outlines the combined ranking of the twenty topics from different entities in the roofing industry.

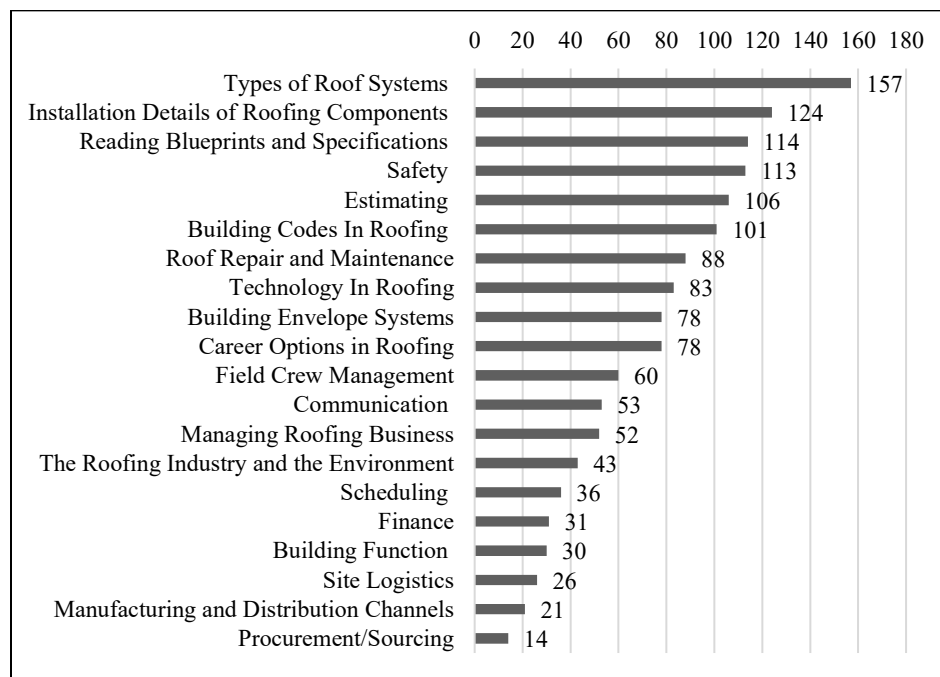


Figure 3: Combined Topic Ranking

However, the combined ranking was heavily favored towards the roofing contractor since the roofing contractor represented 74% of the total survey responses. Further analyses were needed to identify the top ten topics from each major entity, as shown in Table 4, to avoid skewed outcomes toward the roofing contractor survey responses.

Table 4: Topic Rank by Sector

Rank	Contractors	Manufacturers	Distributors
1	Types of Roof Systems	Types of Roof Systems	Types of Roof Systems
2	Installation Details of Roofing Components	Building Envelope Systems	Estimating
3	Reading Blueprints and Specifications	Installation Details of Roofing Components	Installation Details of Roofing Components
4	Safety	Reading Blueprints and Specifications	Safety

5	Estimating	Technology in Roofing	Roof Repair and Maintenance
6	Building Codes in Roofing	Safety	Reading Blueprints and Specifications
7	Roof Repair and Maintenance	Career Options in Roofing	Building Codes in Roofing
8	Technology in Roofing	Building Codes in Roofing	Manufacturing and Distribution Channels
9	Field Crew Management	The Roofing Industry & The Environment	Building Envelope Systems
10	Career Options In Roofing	Estimating	Career Options in Roofing

The final topics for the roofing course were selected based on a two-factor analysis. The first factor of topic selection was any topic ranked among the top ten by all three entities. For example, if the contractor participants ranked “types of roofing systems” in the top ten, an “X” was marked on the table. Any topics that were ranked as top ten by a minimum of two entities were used as the second factor for topic selection. Topics that did not meet the two-factor selection criteria were not selected for this course. Table 5 outlines the details of the two-factor analysis.

Table 5: Top Ten Topics

Topics	Top 10 Topic Selection		
	Contractors	Distributors	Manufacturers
<i>First Factor Selection</i>			
Types of Roof Systems	X	X	X
Installation Details of Roofing Components	X	X	X
Reading Blueprints and Specifications	X	X	X
Roof Safety	X	X	X
Roof Estimating	X	X	X
Career Options in Roofing	X	X	X
Building Codes in Roofing	X	X	X
<i>Second Factor Selection</i>			
Roof Repair and Maintenance	X	X	
Technology in Roofing	X		X
The Roofing Industry & The Environment	X		X
<i>Topics Not Selected</i>			
Building Envelope Systems			X
Roofing Procurement / Sourcing		X	
Roofing Manufacturing / Distribution Channels		X	
Roofing Field Crew Management	X		
Communication			
Managing Roofing Business			
Scheduling			
Financing			
Building Function			
Site Logistics			

99 out of 167 (59.2%) industry participants agreed to assist in developing the course by providing lecture content, product donations, site visits, projects case studies, and online/in-person guest lectures. Table 6 outlines the details of the industry members’ course participation. Over half of the survey respondents volunteered to participate as in-person guest lectures.

Table 6: Industry Participation

Activity	Total (out of 167)	Percent
In-person Guest Lecture	95	56.8%
Volunteer Site Visits	81	47.9%
Lecture Content	69	41.3%
Project Case Studies	69	41.3%
Virtual Guest Lecture	68	40.7%
Product Donations	48	28.7%

Course Implementation

The roofing course was offered as an undergraduate and graduate course based on the topics selected in the curriculum phase and the industry members' participation in assisting with in-person guest lecture, site visits and lecture content. The analysis of the pre and post surveys is shown below.

Pre-Survey

The beginning of the semester survey (i.e. pre-survey) was created to understand the students' background, current knowledge about the roofing industry, interest in enrolling in the course, and perception about the roofing industry prior to the course offering. The pre-survey was distributed during the second week of the course offering. Table 7 shows the student background details, either with prior work experience or a previous formal roofing course.

Table 7: Student Background

Question	Yes		No	
	#	%	#	%
Do you have any prior experience working in the roofing industry?	0	0%	21	100%
Have you ever enrolled in a roofing specific course prior to this course?	2	10%	19	90%
Do you have a family member that works or owns a roofing related business?	0	0%	21	100%

Table 7 shows that enrolled students had no prior experience working in the roofing industry. Only two out of the nineteen students had enrolled in a formal roofing industry-specific course. The two students who have had some experience in a prior roofing course were part of a national roofing competition team prior to implementing this course.

One of the aspects of the pre-survey was to understand the student's motivation in enrolling in this course, as shown in Table 8. Students were asked to rate each statement on a scale of 1 to 10, with one being least important and ten being most important, along with an open-ended question for any other reason.

Table 8: Student Motivation

Rank	Reason	Average (out of 10)	Standard Deviation
1	Learn more about the roofing industry	8.62	1.46
2	Various topics covered in this course	8.57	1.80
3	Industry members' participation	7.81	2.52
4	Recommended by a faculty member/advisor	6.14	3.75
5	Learn about different career options in the roofing industry	6.00	3.23
6	Class day/time	4.86	3.07
7	Recommended by a fellow student	2.86	3.00

Table 8 shows that the curiosity to learn more about the roofing industry, various topics covered in the course, and industry member’s participation were the top three reasons for student enrollment in this course. Typically, student enrollment in a specific course heavily relies upon the recommendation by a faculty member and advisor, which was ranked fourth. Table 8 also showed that the industry member’s involvement in both curriculum development and course implementation was a critical factor for student enrollment.

The pre- survey also focused on collecting and analyzing enrolled student’s perception of the roofing industry at the beginning of the course, as shown in Figure 4.

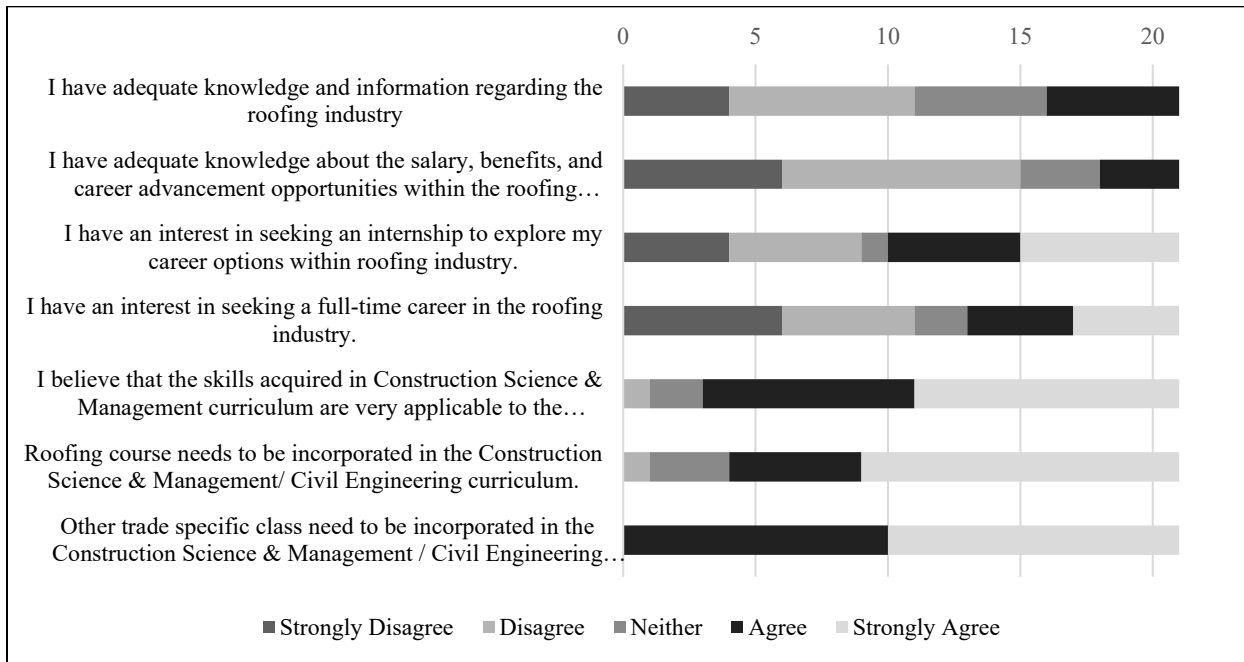


Figure 4: Pre-Survey Student Perception

Figure 4 shows that only five students (23.8%) enrolled in the course agreed that they have adequate knowledge and information regarding the roofing industry. Moreover, only three students (14.2%) enrolled agreed that they have adequate knowledge about the salary, benefits, and career advancement opportunities within the roofing industry, indicating there is a lack of knowledge among students regarding the roofing industry. This showed that there was a lack of knowledge among students about the roofing industry. Since the survey was distributed in the

second week and the topic for the first week was roofing introduction and different career options in the roofing industry, eight students (38.1%) strongly agreed or agreed that they have an interest in seeking a career in the roofing industry.

Seventeen students (80.9%) strongly agreed or agreed that the roofing course should be incorporated into the construction management / engineering curriculum. All twenty-one students (100%) also strongly agreed or agreed that other trade-specific courses also need to be incorporated within the curriculum.

Post-Survey

The end of the semester survey (i.e. post-survey) was created to understand the student's preferred aspects of the course, the courses' impact on student learning about the roofing industry, the perception of the roofing industry, overall course satisfaction, and developing additional courses. Table 9 shows the students' preferred aspect about the course. Students were asked to rate each statement on a scale of 1 to 10, with 1 being least preferred aspect and 10 being most preferred aspect, along with an open-ended question for any other reason.

Table 9: Students Preferred Aspects

Rank	Criteria	Average (Out of 10)	Standard Deviation
1	Industry professionals delivering guest lectures	9.33	0.96
2	Various topics covered in this course	8.90	1.45
3	Layout/structure of the individual class (lecture + in-class assignment)	8.62	1.39
4	Semester Project	8.38	2.01
5	Weekly Assignments	7.57	2.96
6	Class Day / Time	7.52	2.71

Table 9 shows that the industry professionals' involvement in delivering guest lectures, various topics covered in the course, and layout and structure of the individual class were the top three preferred aspects. The layout and structure of the class was an even split between guest lecture and a critical thinking group assignment.

Table 10 shows the student's perspective on the topics that they perceived they had learned the most. Students were asked to rate each statement on a scale of 1 to 10, with 1 being least learned and 10 being most learned.

Table 10: Student Learning

Rank	Topic	Average (Out of 10)	Standard Deviation
1	Low Slope Roofing System – BUR, Modified Bitumen	8.71	1.85
2	Low Slope Roofing System – TPO, EPDM, PVC	8.71	2.23
3	Low Slope Roofing System – Fluid Applied Roofing Systems, Green Roofs, Solar Roofs	8.67	1.53
4	Steep Slope Roofing System – Slate/Metal Panels	8.29	1.93
5	Roofing Estimating	8.24	2.23
6	Safety in the Roofing Industry	8.30	2.32
7	Roof Repair & Maintenance	8.05	2.01
8	Reading Roofing Blueprints	7.86	2.74
9	Reading Roofing Specifications	7.86	2.90
10	Steep Slope Roofing System – Asphalt Shingles	7.71	2.57
11	Technology in Roofing	7.83	2.55

Table 10 shows that the top three topics that students learned the most were low slope roofing systems, which can be categorized as “different types of roofing systems”. Topics students reported learning the least about include reading roofing specifications, steep slope roofing system—asphalt shingles, and technology in roofing. However, the percent difference between the first ranked topic and the tenth-ranked topic was only 12%.

The post-survey also focused on collecting and analyzing the perception of enrolled students regarding the roofing industry at the end of the course offering, as shown in Figure 5.

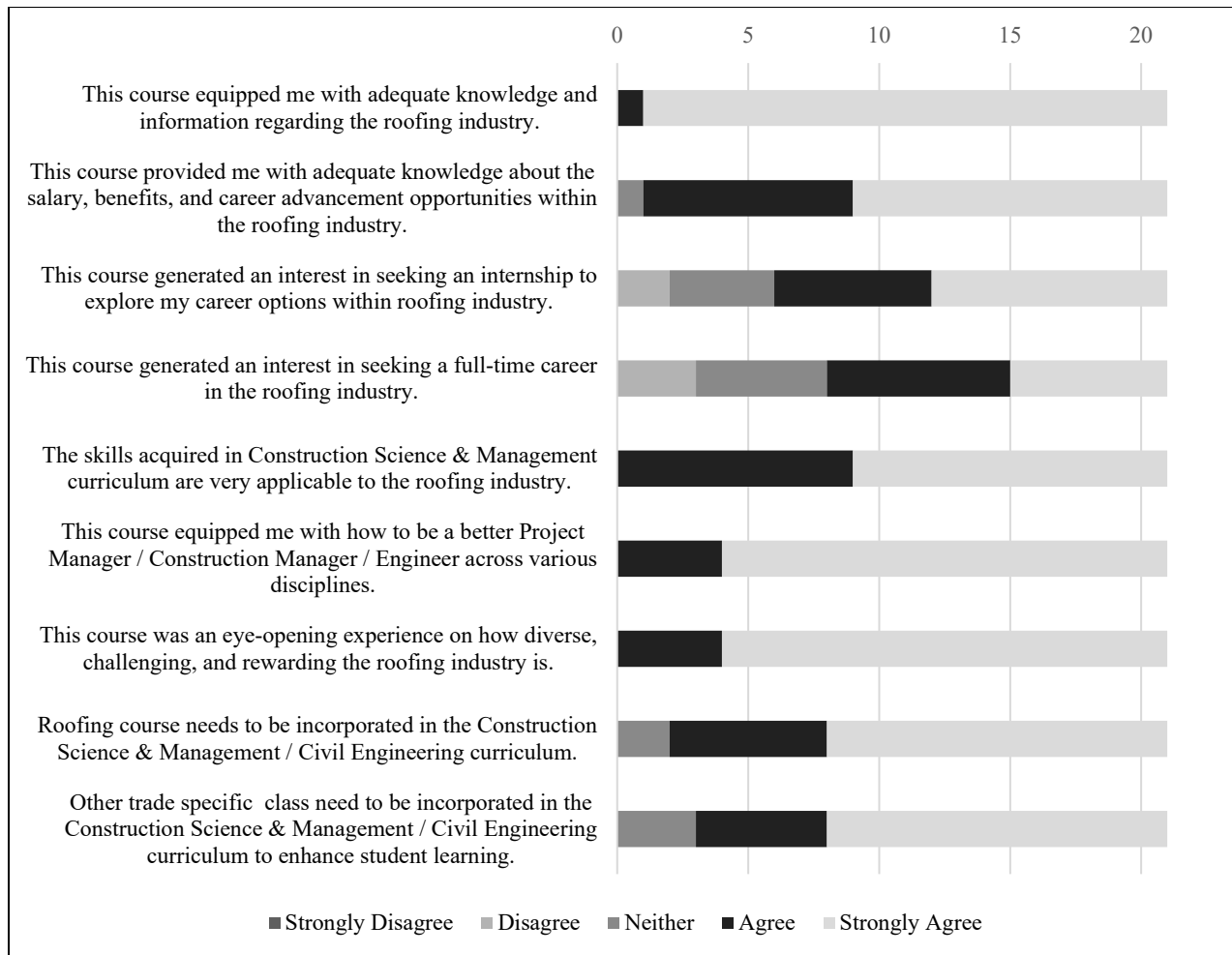


Figure 5: Post-Survey Student Perception

Figure 5 shows that all twenty-one students (100%) enrolled in the course strongly agreed or agreed that this course had equipped them with adequate knowledge and information regarding the roofing industry. Moreover, twenty students (95.2%) strongly agreed or agreed that this course equipped them with adequate knowledge about the salary, benefits, and career advancement opportunities within the roofing industry. At the end of the course, fifteen students (71.4%) strongly agreed or agreed that they have an interest in seeking an internship to explore their career options in the roofing industry. All twenty-one students (100%) also strongly agreed or agreed that this course prepared them to be a better Project Manager / Construction Manager / Engineer across various disciplines. All twenty-one students (100%) of the students also strongly agreed or agreed that this course was an eye-opening experience on how diverse, challenging, and rewarding the roofing industry is.

Comparative Analysis

In order to understand the impact of the roofing course, a comparative analysis of the perception questions between the pre-survey and post survey was performed as shown in Figure 3.

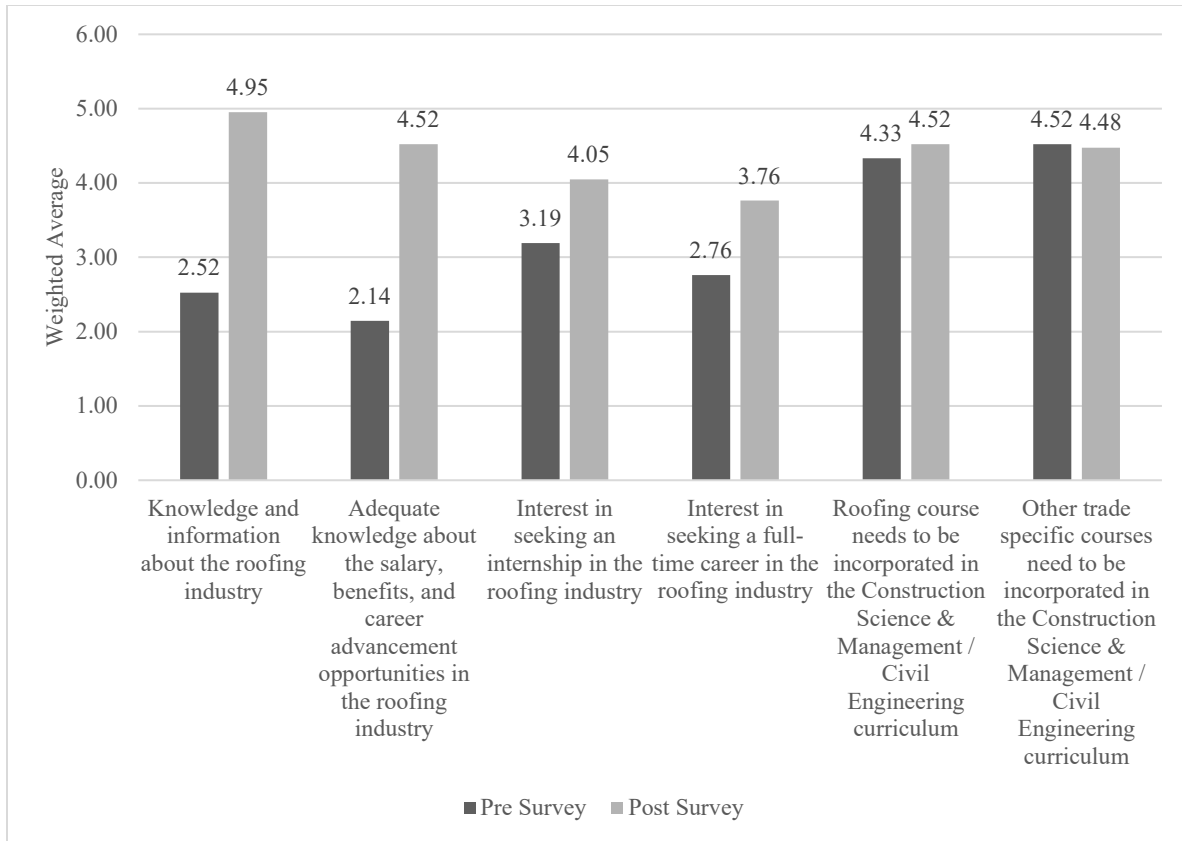


Figure 6: Comparative Analysis

Figure 6 shows a significant increase with a percent difference of 65% in students' adequate knowledge and information about the roofing industry. There was a percent difference of 71.5% in student's understanding of the salary, benefits, and career advancement in the roofing industry. Interest in seeking an internship and interest in seeking a full-time career in the roofing industry also showed a percent difference of 23.8% and 30.7% respectively.

The students were also asked to provide their overall satisfaction with this course on a scale of 1 – 10 with one being not satisfied at all and ten being very satisfied. The overall satisfaction for the course was 9.1 out of 10. 75% of the students rated this course at 9 or higher and 95% of the students rated this course at 8 or higher. Moreover, 75% of the enrolled students expressed an interest in the development of a certificate program in roofing that offers two additional courses.

Conclusion

The study aimed to understand the industry's perception of the current workforce, its perception of offering a roofing specific course at the higher education level, develop the curriculum, implement a three-credit roofing specific course through industry's involvement and understand the impact of this course on student's learning and their perception of the roofing industry. Based on the industry perception survey, it was concluded that the survey's findings aligned with the existing literature. The availability of current roofing workforce and the development of a future workforce is a major challenge faced by the roofing industry. From this study, 92% of

survey respondents agreed that the lack of workforce is a major challenge in the roofing industry today. In order to address this challenge, educating higher education students is critical. From this study, 84% of survey respondents agree that educating university students about the roofing industry can help tackle workforce issues. Hence, from the industry perception survey, it was concluded that there is a need for a roofing sector course at the higher education level, especially since trade-level sub-contractors have started to recruit their future workforce from higher education institutions.

The curriculum for the roofing course was developed by utilizing roofing professional's expertise through an industry-wide survey. A task force, composed of roofing contractors, roofing manufacturers, and roofing distributors, was able to provide ongoing, continuous feedback throughout the study. The study was successfully able to capture the needs of the roofing industry and the concepts that the industry deemed important to be incorporated into the curriculum. Moreover, one of the top three reasons for the student's motivation in enrollment from the pre-survey and one of the top three preferred aspects from the post survey were the "various topics" covered in the course. That was made possible by the active involvement of industry experts in curriculum development and through guest lectures. The layout of the actual class period consisted of an even split between industry professional guest lectures to educate students based on their subject matter expertise and a critical thinking group assignment. Students ranked the "involvement of industry professionals" in the actual course offering as one of the top three reasons for course enrollment and one of the top three preferred aspects of the course. It was therefore concluded that active involvement of roofing industry professionals in both the curriculum development and the implementation phase was a critical success factor.

Comparing the pre- and post-perception surveys, the roofing course was successful in providing the enrolled students with adequate knowledge and information regarding the roofing industry and the various employment opportunities within the roofing industry. The interest in seeking an internship and interest in seeking a full-time career in the roofing industry increased by 23.8% and 30.7%, respectively. The students also reported an overall satisfaction of 9.1 out of 10 for the course.

The study concluded that offering a roofing specific course was not only able to address the current curriculum gap but also provided students with adequate information about the roofing industry and generated student's interest to explore roofing as their potential career path. The framework that was chosen—using industry perception surveys, creating a task force of industry experts and involving industry in the course development and layout—is one that can be easily replicated by other construction management programs, and for other trades.

As for the limitations of this study, it only focuses on one of many trade-level sub-contractors within the construction industry. Similar courses for other trades need to be developed by assessing the current curricula and identifying gaps between construction industry needs and academia. Also, this study was conducted over a period of one semester. The ongoing effectiveness of the course needs to be measured over multiple semesters. Out of the twenty-topics identified, only ten topics were covered in this course. Future additional courses, as part of a certificate program, need to be developed to include additional topics identified by this study.

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Appendix A

Date	Subject
Week #1	Course Introduction; Introduction to Roofing; Career Options in Roofing
Week #2	Steep Slope Roofing Systems - Asphalt Shingles, Concrete / Clay Tiles, Wood Shakes
Week #3	Steep Slope Roofing Systems – Slate, Metal Panels
Week #4	Low Slope Roofing Systems – Built-up Roofing, Modified Bitumen
Week #5	Low Slope Roofing Systems – Single-ply Thermoset and Thermoplastic
Week #6	Low Slope Roofing Systems – Fluid Applied Roofing Systems, Photovoltaic Roof, Vegetative / Green Roof
Week #7	Reading Roof Blueprints
Week #8	Reading Roof Specifications
Week #9	<i>Mid-term Examination</i>
Week #10	Roofing Estimating I
Week #11	Roofing Estimating II
Week #12	Safety in the Roofing Industry
Week #13	Roof Repair & Maintenance
Week #14	Technology in Roofing
Week #15	Final Exam

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