Assessing Experiential Learning in Construction Education by Modeling Student Performance

by

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ABSTRACT

The typical engineering curriculum has become less effective in training construction professionals because of the evolving construction industry needs. The latest National Science Foundation and the National Academies report indicate that industry-valued skills are changing. The Associated General Contractors of America recently stated that contractors expect growth in all sectors; however, companies are worried about the supply of skilled professionals. Workforce development has been of a growing interest in the construction industry, and this study approaches it by conducting an exploratory analysis applied to students that have completed a mandatory internship as part of their construction program at Arizona State University, in the School of Sustainable Engineering and the Built Environment. Data is collected from surveys, including grades by a direct evaluator from the company reflecting each student's performance based on recent Student Learning Objectives. Preliminary correlations are computed between scores received on the 15 metrics in the survey and the final industry suggested grade. Based on the factors identified as highest predictors: ingenuity and creativity, punctuality and attendance, and initiative; a prognostic model of student performance in the construction industry is generated. With regard to graduate employability, student performance in the industry and human predispositions are also tested in order to evaluate their contribution to the generated model. The study finally identifies threats to validity and opportunities presented in a dynamic learning environment presented by internships. Results indicate that measuring student performance during internships in the construction industry creates challenges for the evaluator from the host company. Scoring definitions are introduced to standardize the

evaluators' grading based on observations of student behavior. 12 questions covering more Student Learning Objectives identified by the industry are added to the survey, potentially improving the reliability of the predictive model.

DEDICATION

To my parents and to my brothers and sisters, for your endless support and encouragement.

To Maurice, Bruna, Raphaël, and Alexandra, for your continuing inspiration.

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CHAPTER 1

INTRODUCTION

Many studies in the social realm aimed to explore and outline instructions for teaching and learning STEM subjects. Student Learning Objectives in construction specifically require extensive practice, in an active learning manner (Felder and Brent, 2009) and feedback is necessary at each stage of the learning process. Traditional lectures are becoming ineffective (Ambrose et al. 2010), and studies considering the environment in which the learning is taking place suggest an experiential learning environment with a changing role of the educator in respect to the evolving learning style of the learner. Ericson et al. (1993) describe “deliberate practice” as a highly efficient method to learn and retain more knowledge. Yaacoub et al. (2011) state that employers in the construction industry are recruiting individuals with contemporary and interdisciplinary abilities. This study aims first to validate the necessity of internships as a complementary setting to the academic environment, for learning in construction education. University programs struggle to keep up with the rapidly changing expectations of engineering graduates (Graham et al. 2009), as well as the technological demands of the market. There is a gap between what is expected from graduating engineers and the set of skills that they possess. The academic environment does not have all the necessary components to preparing a student for working in the profession. Baily (2017) states that internships are used to bridge that gap.

Chapter 2 covers an extensive literature review on the overarching social and cognitive theories, including Bandura’s Social Cognitive Theory, Piaget’s Cognitive Development Theory, Kohlberg’s Moral Development model, Gilligan’s Moral

Development model, and Perry's theory of development of college students. The study also describes the prominent concepts as applied in construction education based on Kolb's learning styles model and Bloom's taxonomy, followed by a literature analysis. The study will include limitations of these theories and explore opportunities in internships for assessing student performance.

The literature review exposes factors that are examined throughout the study, such as the environment in which the learning is taking place. Emerson (1976) states that the learning environment impacts student outcomes, and suggests that a learning environment which promotes consistent learning is recommended for a better learning experience. The study discusses this notion and compares it to the literature. Bourdieu and Passeron (1979) and James (1995) discuss predispositions and human variables, stating their impact on student experiences. Data is collected from surveys completed by the industry, scoring student performance in specific areas during their internships. The sample includes 1127 students who completed their internships between 2012 and 2017, descriptive statistics and exploratory analysis are described in the first and second chapter. The survey includes 15 questions, covering skills in accordance with recent Student Learning Outcomes (SLOs) as defined and identified by the American Council for Construction Education (2013).

Construction employment is expected to grow by 12.9% by 2024 (U.S. Bureau of Labor Statistics, 2019). The National Science Foundation's recent report indicates that half of the workforce added each year to the industry is educated in construction – bachelor's degree – yet inexperienced, which shows the need for mandatory internships exposing students to their future work environment. Internships help improve skills needed in the industry, since experiential learning is proven to be the dominant learning style in construction. This study aims to investigate the construction industry valued skills, by performing an exploratory analysis on the survey results. The goal is to better understand the skills needed by the students, thus required by the academic unit, to improve the learning process of construction students.

Chapter 3 examines interns' scores on each question of the survey – covering SLOs – and overall performance on the job, to attempt generating a predictive model from the relationship between the variables. The suggested approach considers internships as an experiential learning framework that provides opportunities to all the learning styles identified in the literature, setting the outline for the data analysis. Demographics of student interns will be investigated and the survey results will be analyzed to examine correlations with student variables – including human data and academic efficacy/achievement. Highest predictors of student overall performance in the construction industry are identified and used to generate a predictive model, followed by comments on its reliability and threats to validity.

One of the preliminary correlations computed on the dataset used in this study between the interns' final grade on the internship course and their performance during the internship validate Donhardt's (2004) statement: correlation between grades and professional success is close to zero. This is mainly due to the fact that different organizations are measuring different student outcomes. The academic unit is assessing knowledge while industry evaluates performance in addition to attributes commonly related to soft skills. Moreover, the set of skills measured in the industry differ between the various companies, due to different company culture, size, expectations and needs on a certain project, etc. The scoring process may also differ between direct evaluators in the same company, due to several possible reasons such as the position of the evaluator, the time spent with the intern, the commitment to the evaluation process and the interpretation of each score.

Interpersonal and soft skills are emphasized by Lang et al. (1999), in a study concluding that these skills allow an individual to achieve high-performance results in a workplace. Holcombe (2003) describes the capabilities related to business, economic, or any other aspect that is not directly related to a technical construction task as the essential skillset required of a graduate entering the market. Employers are demanding higher levels from their recruits (Firth, 2011) which is the responsibility of universities, according to Hopp (2000). The Accreditation Board for Engineering and Technology (2010) confirms Hopp's statement, by including the non-technical skills as part of the criteria of accreditation. Filling competency gaps are required form the academic institution, and in order to do so, measurements in the experiential learning environment need to be improved. Internships provide the environment required for learners to benefit the most from experiential learning, and offer a suitable setting for assessing the skills in question, according to Kolb (1987).

The evaluation of student performance in the industry faces many challenges including aligning evaluators on the measured value and keeping the evaluation objective and absent of direct company benefits. Skills are not easily defined, and there is a lack in the scientific means of measuring an individual's level in each skill. **Chapter 4** aims to explore the threats to validity identified in the dataset, specifically the learning environment and the scoring system. The study describes the difference between the measured skills in both environments. The highest predictors of student performance in the industry are identified again in chapter 4 with considerations to the identified threats, in order to compare with the previously generated model and evaluate its reliability. Moreover, an Inter-Class Coefficient (ICC) is be computed to examine the agreement between different industry evaluators.

Lastly, **chapter 5** discusses the overall conclusions and suggestions resulting from this study, combining the literature analysis and the statistical analysis results in a list of contributions made to the body of knowledge. The flowchart in Figure 1.1 illustrates the steps if the research described in this chapter.

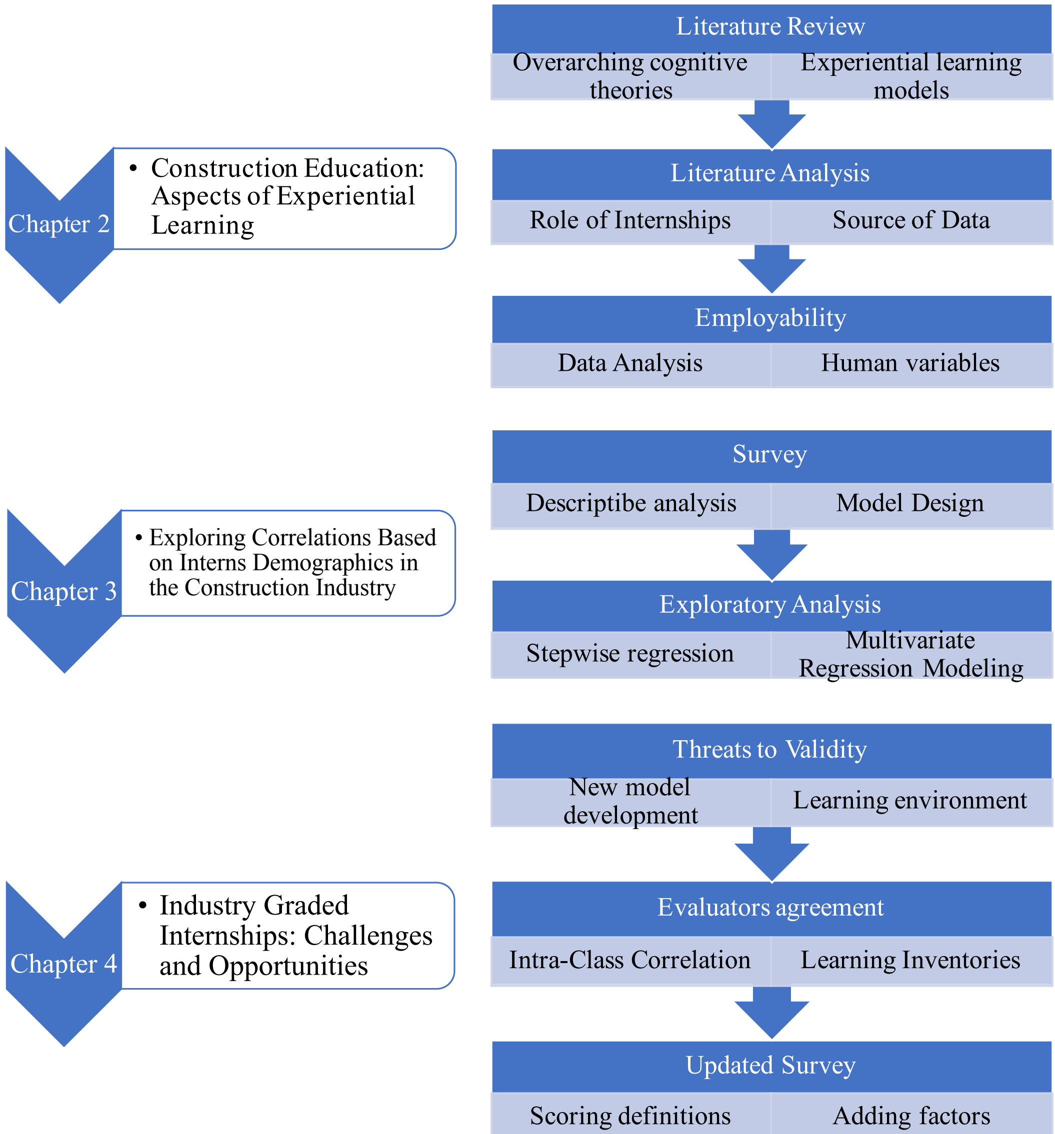

Figure 1.1. Research Steps: Chapters 2 – 4

CHAPTER 2

CONSTRUCTION EDUCATION: ASPECTS OF EXPERIENTIAL LEARNING

2.1. ABSTRACT

Studies in recent decades prove the importance of experiential learning. Cognitive theories and moral development concepts helped institutions improve their curriculum and teaching methods. This study elaborates five predominant social theories as a basis of analysis, including: Bandura’s Social Cognitive Theory, Piaget’s Cognitive Development Theory, Kohlberg’s Moral Development model, Gilligan’s Moral Development model, and Perry’s theory of development of college students. Applying concepts such as Kolb’s experiential learning on construction education highlights the advantages that some theories present to the field. Experiential learning theories complemented by detailed taxonomies of education objectives provide a deeper understanding of learning styles and how they define the evolving nature of a learner’s position. The literature analysis suggests that experiential learning is essential for construction education, and internships in particular present the proper environment that allows the learner to be in the center of the process, advancing the learning experience. Predispositions and human variables are shown in the literature as often overlooked when investigating student experiences in the industry. The results of this statistical analysis that examines the impact of these variables on student performance in the industry showed that there is no statistical significance between any considered subgroup of individuals and their performance in the industry.

2.2. INTRODUCITON AND OBJECTIVE

Extensive studies and experiments in the last decades aimed to explore and outline instructions for teaching and learning STEM subjects. Prominent concepts mainly considered the social aspect and the capabilities of the learners, but not the environment of the learning process. Felder and Brent (2009; 2016) state in one study that in order to understand complex material – such as expected learning objectives in construction – extensive practice and feedback are necessary for the needed techniques to become clear and the required skills to be comprehended. Research in recent decades has shown how learning happens, and how most traditional lectures are ineffective (Ambrose et al. 2010). Felder and Brent (2009) call for active learning, in contrast with traditional lecture-based learning. Recent efforts started considering the environment in which the learning is taking place, with the goal of proving that presenting a suitable framework leads to the increase of an individual's learning capabilities and knowledge retention. In that manner, internships provide the environment needed for "deliberate practice", described by Ericson et al. (1993) as a highly efficient method to learn more and retain knowledge longer. In an internship environment, a set of clear and specific goals and expectations can be more described in the application under scope of work; allowing the evaluator to track the student performance in a manner dedicated to each activity – which translates into specific Student Learning Outcomes (SLOs). The purpose of this study is not substituting lectures with internships; but it is to examine the essential nature of experiential learning, especially internships, as a complementary setting for learning in construction education.

This chapter first presents the governing social and cognitive theories introduced in the past decades as a basis for learning. The literature will conclude with applying one of the prominent concepts on construction education. Then, an analysis of the literature will include limitations of these theories and opportunities found in internships for assessing student performance.

2.3. RESEARCH METHODS

The study first reviewed cognitive theories that outline the overarching concepts of learning and the student's role. Theories include Bandura's Social Cognitive Theory, Piaget's Cognitive Development Theory, Kohlberg's Moral Development model, Gilligan's Moral Development model, and Perry's theory of development of college students. Then, this chapter discusses limitations of the presented concepts and addresses construction education using Kolb's model and Bloom's taxonomy. The literature review also emphasizes the need for the adequate environment for better results when assessing student performance, and that opportunities exist in an internship setting. Finally, the study presents experiential learning, more specifically internships, as an essential part for completing the mentioned models, as part of the analysis of the literature.

2.4. OVERARCHING COGNITIVE LEARNING THEORIES

Experiential learning cannot be discussed without the social aspect that it demands, outside of the classroom where students are expected for the first time to learn from observing and reacting to events on the field. Five predominant social theories will be briefly described to better understand the framework of the social aspect of this paper.

Bandura's social cognition discusses the progress of an individual from the *forethought* phase to *the moral disengagement* phase. "Humans are product of learning" states Bandura (1989). The theory is summarized Figure 2.1.

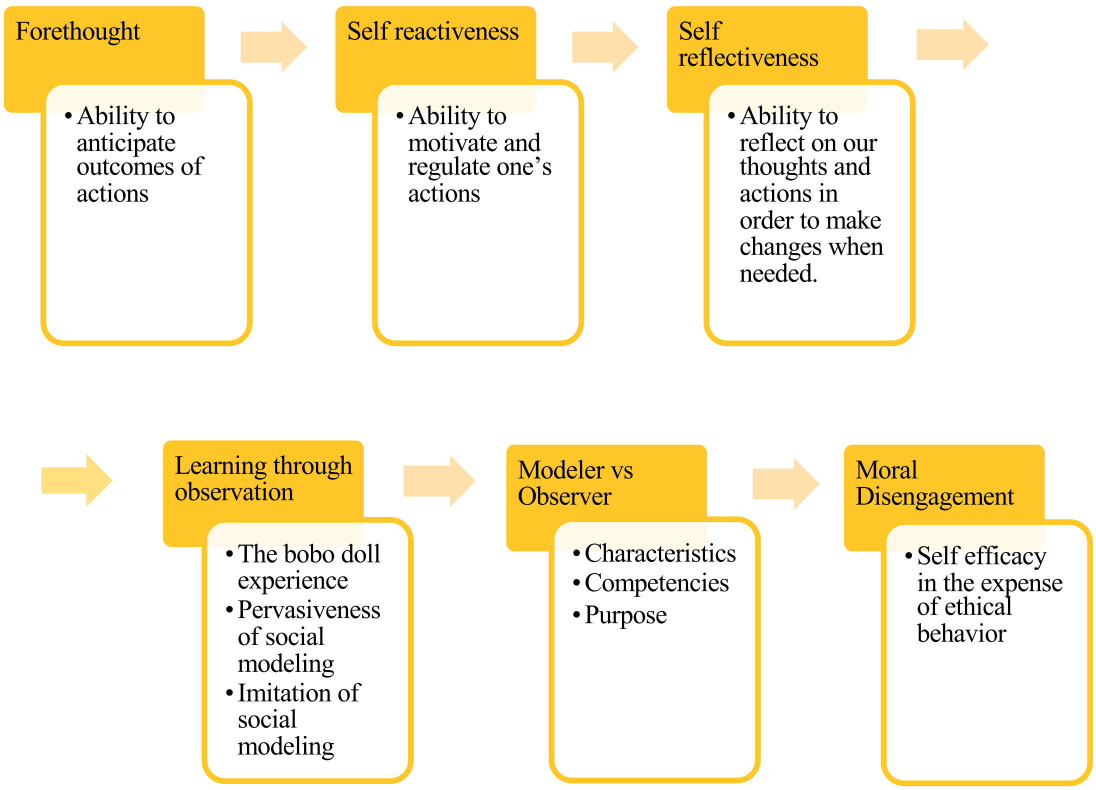

Figure 2.1. Summary of Bandura's Social Cognitive Theory [Adapted from Bandura (1989)]

According to Bandura's theory, learning is a result of a dynamic relationship between the environment and the human behavior in that environment (Bandura, 2001). In another study, Bandura (1997) explains that self-beliefs also impact learning capabilities, since they translate the perceptions of the environment where learning is occurring – influenced by individual characteristics – into behavior. Self-efficacy, in this approach, is an individual's beliefs about their capability to perform a task (Pajares, 2007). Pajares also emphasizes that social interactions can improve or diminish one's capabilities. Several studies found that self-efficacy beliefs are not significant predictors to learning capabilities (Vancouver et al. 2001; Heggestad and Kanfner, 2005), stating that factors such as past performance and general cognitive ability explain better the variance perceived in learning outcomes. However, the majority of research results support the findings form Bandura's study, affirming the role of "mediator" (Lee et al, 2015) between self-efficacy and performance (Bandura, 1997; Lent et al. 1991; Lent et al. 2003; Brown et al. 2008) Bandura's theory emerged from social-cognitive concepts (Purzer, 2014); it highlights the impact of positive and supportive encouragements in addition to students experiencing mastery, on facilitating the learning process.

Piaget's Cognitive Development is a theory that introduces the concepts of safety and esteem to the model, binging the *concept introduction phase* and the *exploration phase* closer together in a cycle, going through the *concept application phase*. Piaget (1964) emphasized the importance of interaction with materials of a given subject as well as with other students, as shown in Figure 2.2.

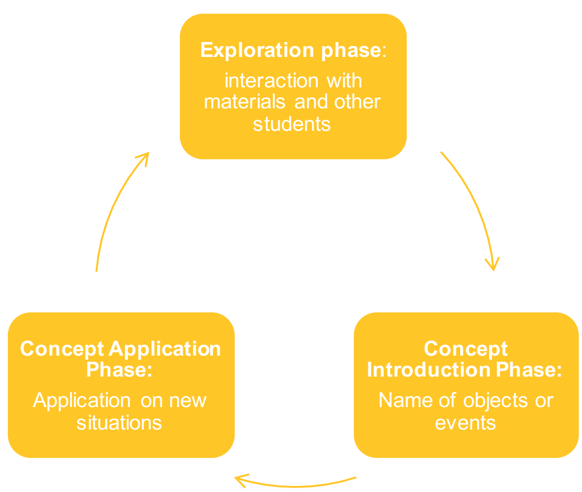

Figure 2.2. Piaget's Cognitive Development Theory [Adapted from Piaget (1964)]

One major drawback of this study is the limitations of the sample, which was only children younger than 12 years old, with most of the studies being based on case studies with no correlational support. Piaget's hypothesis states that individuals are born with reflexes; however, constructed schemes replace these reflexes when they are used to adapt to a certain environment (Huitt et al, 2003). Piaget's theory can be summarized by progress stages characterized by a unique way a person understands information (Ojose, 2008). During the sensorimotor stage, children learn eye-hand coordination and objects, in addition to the concept of numbers (Martin, 2000; Fuson, 1988). In the preoperational stage, symbolic thoughts are developed with the increase use of language (Thompson, 1990). During the concrete operational stage, individuals start performing basic operations such as classification and ordering, enhanced mainly by hands-on experiences (Burns and Silbey, 2000). In the formal operations stage, students can finally develop the ability to think abstractly and reason hypothetically (Anderson, 1990). In a study on children learning activities, Mayeski (2001) emphasizes the importance of direct experiences in the appropriate environment when it comes to learning. This was highlighted once again by the concept of "symbolic function" (Wadsworth, 2004), where individuals begin to distinguish objects in their immediate environment.

Lawrence Kohlberg starts his study on the development of moral thinking with Piaget's model (Kakkori and Huttunen, 2018). Although Piaget is considered a pioneer of moral judgments research, extensive interest in moral reasoning and development was generated primarily by Kohlberg's model (Giammarco, 2016). Kohlberg's moral development theory, on the other hand introduces ethics into a model. As seen in Figure 2.3, *Obedience vs punishment* being the first phase of moral development, an individual goes through *self-interest, good boy attitude, law and order,* to achieve eventually the *social contract* (Duska and Mariellen, 1975). In the same direction, an individual evolves from self-interest, to family interest, through community interest, attaining humanity interest. Also, a major limitation of this study is the sample which is comprised of all young adult, white males, posing threats to validity.

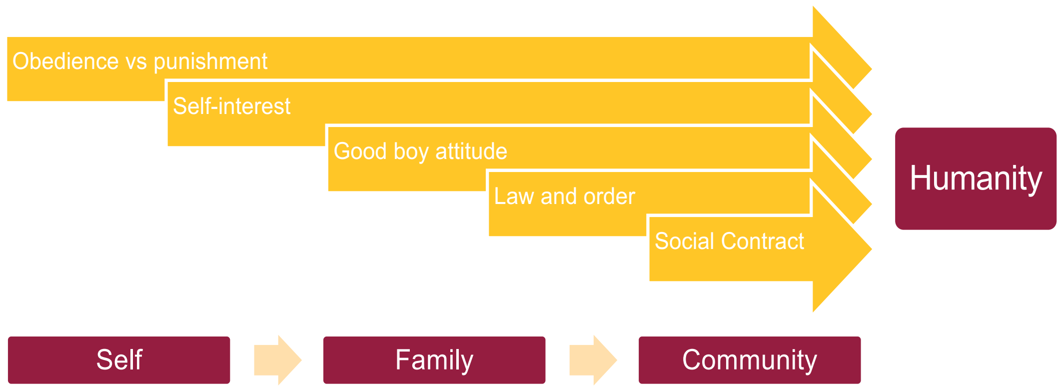

Figure 2.3. Kohlberg's Moral Development Model [Adapted from Duska and Mariellen (1975)]

The pre-conventional morality stage includes the first two phases – *obedience vs punishment* and *self-interest* – and is characterized mainly by the wish to avoid punishment or injury. Although more common in groups of children, adolescents and adults demonstrate similar behavior rarely (Long, 2012). The conventional morality stage includes the next two phases – *Good boy attitude* and *law and order* – where individuals shift from egocentricity to recognizing the need for law and order to maintain a functioning society where they try to conform to a specific role (Kohlberg, 1976). In order to progress in the post-conventional reasoning stage – phases that define *social contract* – Kohlberg's theory underlines the importance of reflecting upon a response after experiencing a moral dilemma (Long, 2012). People develop a sense of ethics and consider moral dilemmas when they recognize the ambiguity of the dualistic approach of right and wrong actions.

Criticism of Kohlberg's study came largely from Carol Gilligan, his student. Gilligan presented the model in a more inclusive fashion (Walker et al, 1987). The more recent moral development theory includes three levels and two transitions in between, summarized in Figure 2.4.

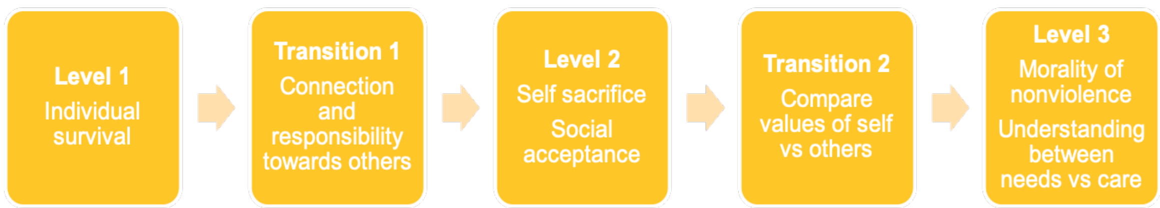

Figure 2.4. Summary of Gilligan's Moral Development Model.

Gilligan introduces *care reasoning* to the model and suggested that it consisted of three stages (Walker, 2006): one's desire not to be hurt, then self-sacrificial caring for others, and finally a achieving the balanced connection between self and others. In the presented model, Gilligan (1982) argues that identities are based on intimate relationships, whereas moral dilemmas are related to conflicting interpersonal responsibilities. Walker (2006) explains that men and women use different frameworks to understand moral dilemmas. Empirical investigations of gender differences failed to provide consistent evidence on moral development measures (Bruess and Pearson, 2002).

Social exchange theories also emerged in terms of social studies reflecting on experiential learning, but this time with a focus on a social cost-benefit analysis. Human behavior is shown to be aiming at maximizing social gain (Emerson 1976). The same theory suggests that individuals need to understand the benefit of the learned information within a learning environment that allows consistent learning, allowing the learner to meet the promised expectations.

Another popular theory which incorporates context and the notion of a "relativistic world" in education is Perry's theory of development of college students. In one of the first studies that focus on college students, Perry (1970) explores how college students respond to education, and his model defines different positions – as opposed to stages and levels in other theories. Nine positions are grouped in four categories: *Dualism, Multiplicity, Relativism, and Commitment in Relativism*. Briefly, *dualism*, is described by understanding facts and knowing what is right and what is wrong. *Multiplicity* gives way to opinion and students start to distrust authority, reason abstraction, and science. *Relativism* discusses the existence of disciplinary reasoning through criteria and arguments. Lastly, *commitment* underlines the positions where students realize they have to commit to a solution and make choices, by understanding the context of each choice. According to Perry, the move between the four positions during college years results in intellectual and ethical development.

The literature is not limited to the theories presented in this section. However, the aim from this part of the chapter was to introduce overarching notions of cognitive theories and show the importance of the learner's involvement in each of the theories, proving that the essence of knowledge is subjective and relative to the individual's experience. This section will be concluded with Kolb's experiential learning cycle. Brouwer et al (2015) discuss the *Learning and Relearning* process introduced by Kolb in 1976 to be the core of enabling students to progress from learning to creating. An individual is shown to be in the perpetual learning cycle, passing along the concrete-abstract and active-reflective continuums, through the following stages: *reflector, theorist, pragmatist, activist*. The model is later also developed by Peter Jarvis (1987) to consider situational and cultural factors.

2.4.1. Kolb's Experiential Learning Theory and Learning Styles

Kolb's Experiential Learning Theory (ELT) is one a popular educational theory in higher education. Kolb's model is frequently cited in the literature in many areas (Healey and Jenkins 2000). According to Winstead (1999), earlier studies have been used as a reference for Kolb's work. Dewey (1938) emphasized the importance of experience in the learning process. Considered the pioneer of experiential learning, Dewey highlighted the assumption that an "organic connection between education and personal experience" exists and is essential for learning (Kolb, 1984). Lewin (1951) underlined Active Participatory Learning; and Piaget (1970) studied individual's intelligence as a result of their interaction with the environment. Structuring and sequencing the curriculum have been the focus of these studies since, and Kolb's theory is depicted as a way to improve that process – by focusing on student learning styles. Nine style types were introduced in the new Kolb Learning Style Inventory (KLSI 4.0), including the following:

1. Initiating: the ability to initiate action when dealing with experiences and situations.
2. Experiencing: the ability to find meaning from deep involvement in experience.
3. Creating: the ability to create meaning by observing and reflecting on experiences.

4. Reflecting: the ability to connect experience and ideas through sustained reflection.
5. Analyzing: the ability to integrate and systematize ideas through reflection.
6. Thinking: the capacity for disciplined involvement in abstract reasoning, mathematics and logic.
7. Deciding: the ability to use theories and models to decide on problem solutions and courses of action.
8. Acting: strong motivation for goal directed action that integrates people and tasks.
9. Balancing: the ability to flexibly adapt by weighing the pros and cons of acting vs. reflecting and experiencing vs. thinking.

These nine learning style types are based on the previous version of the inventory which includes four types, shown in Figure 2.5: diverging, assimilating, converging, accommodating. The purpose of the updated version is to take into account the individuals which found their results between the lines of two different types, providing more clarity and accuracy to the inventory. This paper relies on the four original types, which are based on the relationship between the two scales of "cognitive growth and learning", four modes are presented: Concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). The two orthogonal continuums can be represented by the "concrete-abstract continuum" and the "reflective-active continuum".

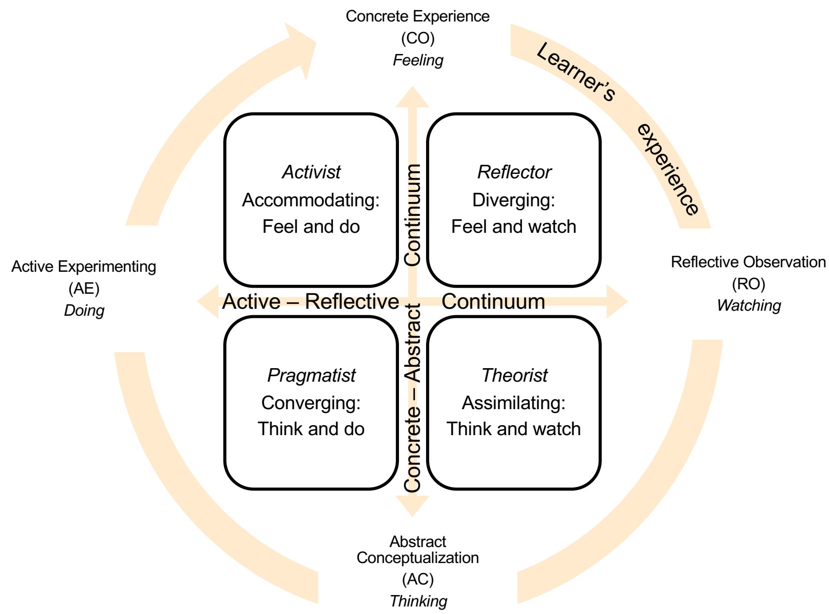

Figure 2.5. Process of Learning: Kolb's Four Modes and Two Continuums [Adapted from Brouwer et al. (2015)]

Winstead (1999) defines the "concrete-abstract continuum" as an answer to how participants in an activity acquire information from their environment – based on their inclination for involvement and contribution with Construction; in comparison to conceptual analysis (logical thinking and evaluation) which is based on basic theories in AC. On the other hand, the "reflective-active continuum" shows how individuals process the obtained information, and it separates observational learners RO from active participants AE. Individuals are continuously moving along these continuums, with evolving characteristics, as shown in table 2.1: how they will obtain information and how they will process it in order to address any challenge (Atkinson and Murrell 1988).

Table 2.1. Kolb's Learning Styles Characteristics

Characteristics	**Reflector** (R) *Diverging*	**Theorist** (T) *Assimilating*	**Pragmatist** (P) *Converging*	**Activist** (A) *Accommodating*
Grasp understanding through	Concrete Experience	Abstract Conceptualization	Abstract Conceptualization	Concrete Experience
Transform experience	Reflective observation	Reflective observation	Active experimentation	Active experimentation
Strength	Imaginative abilities	Theoretical models	Quickly adopt one answer (as opposed to R)	Know how to adapt (opposed to T)
Preference	Have multiple perspectives for a meaningful whole	Use theories and integrate data	Deal with things rather than people	New experiences
Nature	People oriented, emotional	Interested in abstract concepts	Unemotional	Risk takers, intuitive
Relevant activities	Brainstorming, discussion, visualization	Lectures, reading, analyzing	Laboratory, simulations, problem solving	Work experience, open-ended problems

2.4.2. Applying Kolb's ELT to Construction and Engineering Education

Lee et al. (2008) conducted a case study with the main purpose of applying Kolb's ELT to construction and engineering education. The study explained how the theory can be defined within two frameworks: macrolevel and microlevel. The experiment engaged students in formwork design, as an example of a real construction task to investigate the interrelation between fundamental knowledge (learned in class) and building higher-level skills (problem solving and critical thinking acquired through experience), as presented in Kolb's ELT.

Lee et al. explain that the construction industry is considered an experience-oriented field where individuals need to utilize experience and general knowledge in any given task. While some practices can be fashioned in a classroom setting, there is no single way to learn all aspects of construction. Theoretical background is certainly obtained through academic courses; however, professional knowledge is attained after involvement in real construction projects. The goal is to use Kolb's ELT as a way to "enhance the education of engineering students by linking educational practice and theoretical background". The macrolevel framework represents the basics of learning in general, whereas the microlevel framework is applied to smaller and specific parts of the macrolevel. The following list will cover the macrolevel framework as the definition of each of the quadrants:

- Quadrant 1: defined by the question "*Why"* in the case study and by *Reflector* in this paper: initial involvement by experiencing real situations which are not encountered in a typical classroom setting. Students are expected to learn why a particular topic is important from new observations made on field trips for instance.
- Quadrant 2: referred to as *"What"* and *theorist*: theoretical aspects of construction engineering can be learned in this stage. Students start building knowledge by understanding concepts and developing conclusions.
- Quadrant 3: referred to as "*How*" or *Pragmatist*: Students learn how to apply the learned concepts to given situations through examples and practices. Individuals in this stage can start solving problems encountered in different situations.
- Quadrant 4: also defined by the question "*What if*" and *activist*: this stage includes projects such as designing or building models, which leads to a complete first learning cycle. It is worth mentioning that individuals can go through the same

cycle multiple times; however, every learning cycle will incorporate a different level of understanding of formerly acquired knowledge.

One of the first observations in the study was the essential role that experiential learning plays in the cycle – quadrant 1, providing a basis for the rest of the learning process. Another point was the obvious improvement that the students showed after completing quadrant 4, proving that the students were able recreate their steps in the cycle when different tasks were presented, proving the increase in knowledge retention at the end of the cycle. Bernold (2003) explains that in order to fully understand a subject, guiding the individual through the cycle is essential, even when it is not the individual's preferred learning style. In fact, Stice (1987) evaluated knowledge retention after each of the cycles, and found that 90% subject knowledge retention was achieved when all four stages of the cycle are followed, in comparison to a low of 20% when following the one stage only – 50% with two stages and 70% with three stages.

In a study on 170 student reports from internships across the United States, Tener et al. (2001) concluded that almost half of the students reported noticeable improvement in learning and understanding assigned tasks by the active experimentation, once again showing that accommodative learning, referred to as *activist* in quadrant 4, is the preferred learning style which is typically encountered in construction internships. Conversely, in a study on undergraduate students' learning style preference, Sharp (1997) found that only 10% prefer the diverging style – quadrant 1 which includes activities such as internships. Lee et al. (2008) found almost the same results, with 9% of the students choosing the diverging style as their preferred learning style. The numbers also show that the majority of the students (almost 78%) are found alternating between the assimilating and converging styles, i.e. the two quadrants in the bottom of the cycle, *theorist* and *pragmatist*. McCarthy (1987) explains that teaching in the classroom falls under a "pendulum style" routine, alternating between the two bottom quadrants. This results in limiting the benefits of exploring other quadrants such as the higher retention of knowledge, limiting the potential of students with preferred styles in the first and fourth quadrants, and precluding the full cycle for all students. Wankat and Oreovicz (1993) describes individuals in the two bottom stages of the cycle as rarely motivated, with a low possibility of completing a cycle and attaining quadrant 4, i.e. *activist*. It is by reaching quadrant 4 that students are able to "learn how to learn" in a manner applicable to a future work environment (Tener et al. 2001).

Internships are becoming mandatory in construction programs, such as the construction program in Del E. Webb School of Construction, in Arizona State University. According to Freeman et al (2014), a meta-analysis computed on active learning in STEM programs showed that student performance increases with active learning. Construction students can only move through quadrants by being involved and starting their experiential journey along their education, which will allow educational institutions to keep track and analyze results from both sources (classroom and experiential learning environment) to better understand trends and evolution of their students. This explains the need of acquiring and exploring data from surveys, where the industry, more specifically a direct evaluator in the host agency, grades student performance in order to relate results with academic achievement.

2.4.3. Bloom's Taxonomy of Educational Objectives

In a study on how to use instructional objectives, Gronlund (2008) explains that learning objectives are precise statements that describe what students should be able to do if they learn what the instructor attempts to teach them. Providing a list of learning objectives to STEM students, however, is similar to "spoon-feeding" them, according to Felder and Brent (2016). The real objective for construction students should be to figure out what they need to learn. In order to be able to do that, Bloom introduces three domains in which all learning objectives are sorted: cognitive domain (Bloom and Krathwohl, 1956), affective domain (Krathwohl et al, 1984), and psychomotor domain (Simpson, 1972).

Learning objectives in any curriculum should involve objectives from the cognitive domain, which includes 6 levels of learning as of Anderson and Krathwohl reorganized definitions (2003), as follows:

- Level 1: Remembering. Replicating known procedures and memorize facts.
- Level 2: Understanding. Comprehending the meaning of instructions and interpreting the problem in question.
- Level 3: Applying. Being able to implement a concept in a new situation.
- Level 4: Analyzing. Solving and modeling complex problems. Distinguishing between facts and inferences.
- Level 5: Evaluating. Making and supporting judgements.
- Level 6: Creating. Designing something new and formulating new ideas.

The affective domain will not be discussed in this study, but it is important to mention that construction students should be exposed to courses that develop values (belonging to the affective domain) such as ethical reasoning. Construction students should be exposed to the psychomotor domain – since they will be exposed to machineries (in some cases heavy machinery) and kinetic technology – which is generally easiest to apply in an experiential learning development environment (Dave, 1967). There are 7 levels in the psychomotor domain:

- Level 1: Perception. The ability to use sensory cues to guide motor activity.
- Level 2: Set. Including mental, physical, and emotional sets, relating to readiness to act and to respond to a changing situation.
- Level 3: Guided Response. This level is characterized by improving performance by practice, based on trial and error – early stage in learning complex skills.
- Level 4: Mechanism (basic proficiency). Intermediate stage in learning complex skills, characterized by habitual responses developed from level 3.
- Level 5: Complex Overt Response (Expert). Being able to perform complex, quick, accurate, and highly coordinated movement pattern with minimum energy on focus – automatic response.
- Level 6: Adaptation. Skills are extremely developed, allowing the learner to modify complex patterns to changing situations.
- Level 7: Origination. Creating new movement patterns, creative capability to solve specific identified problems.

The psychomotor domain includes coordination and movement. Simpson (1972) states that skills in this domain are generally measured in terms of speed, precision, and more importantly procedures and techniques in execution.

2.5. LITERATURE ANALYSIS

2.5.1. Role of Internships in Taxonomies and Theories

Dee Fink's Taxonomy of Significant Learning (2003) defines learning in terms of change. The taxonomy includes 7 types of learning, and are distinguished by their interactive nature rather than hierarchical like previous theories, as seen in figure 2.6. Dee Fink explains that achieving any learning type can enhance the other types, and more importantly, that learning is not a "zero sum" game. It is a synergistic relationship between the different major kinds of learning, presented in the following list:

- Foundational Knowledge: understanding and remembering information and ideas. It provides a basic understanding necessary for any kind of learning.
- Application: developing skills, managing projects practically, critical and creative thinking. It allows other kinds of learning to become useful.
- Integration: intellectual power connecting ideas and people.
- Human Dimension: understand oneself and others, and the role that each play.
- Caring: Developing new feelings, interests, and values.
- Learning how to learn: Becoming a better student, inquiring, and self-directed.

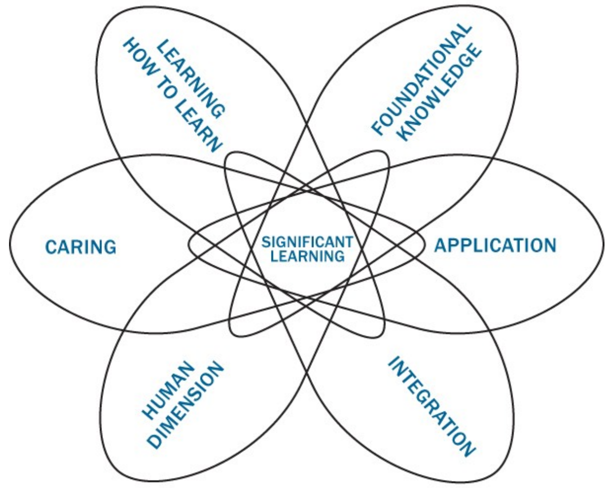

Figure 2.6. Dee Fink's Significant Learning [Adapted from Dee Fink (2003)]

An environment able to promote all learning types can be considered "significant". Integrating previous theories from the literature to Dee Fink's, internships prove a major role in the collaborative environment required to provide ultimate learning opportunities to students. Internships close the cycle that Kolb introduced, and provide an environment needed for most of Dee Fink's types of learning.

2.5.2. Internships as Source for Data

Experience is crucial in an industry such as construction where problems are real and solutions must be creative, effective, and more importantly applicable. Experience relative to the construction industry and the activities available to an undergraduate student from any civil/environmental/construction engineering program can be achieved by a part-time job, which has a high probability of decreasing academic efficacy – which is part of the criteria affecting future employability of a student. A better exposure to real work is better fulfilled by an internship, recommended by an academic organization and sometimes mandatory. Construction students should be involved in the field early on; the earlier the better in order to narrow down their choice of sector and build their program of study accordingly. The earliest opportunity for involvement that does not jeopardize academic achievement is an internship as part of the program, with accountability, and credits counted toward coursework units. Inkster et al. (1995) provide the following definition for internships, cited by numerous previous studies on experiential learning:

"A structured and supervised professional experience within an approved agency, for which a student earns academic credit. It usually involves a specified period of time with employment status while on leave from the academic program. It usually has little or no academic content or faculty involvement, except for placement assistance."

Inkster et al. depict the position of the student intern as central to the "three-way partnership" between academic institution and the host agency, as seen in Figure 2.7.

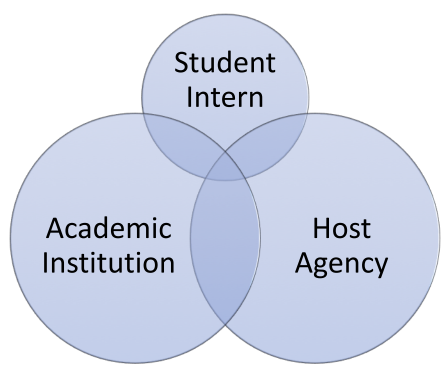

Figure 2.7. Internship as a Three-Way Partnership

Tener et al. (2001) emphasize the importance of the close working relationship between the academic unit and the company hosting the internship, both aiming to provide an environment suitable for the intern's learning. Benefits to all three parties exist in a partnership. In addition to the benefits mentioned previousl, Russel (1991) states that increased academic achievement was attained by the students after completing an internship. Tener et al. observed a development in students' self-efficacy, improving their choices and behavior both in the classroom and the work environment according to a study by Emory University (2000). Johnston (1990), Russel (1991), and a report by NCCE (1999), all showed benefits presented by internships to universities as well as the host agencies. These include, but are not limited to:

- Keeping the curriculum aligned with the industry needs through communication and input from the host firms
- Student access to equipment and technology
- Building and strengthening a positive working relationship with the industry.

Internships also give the host agency insight on potential future hires – which also helps with increasing employment rate for the university. Identifying potential employees during internships reduces the expenditures of the recruiting process, providing a selection of educated individuals, allowing a closer and personnel evaluation of the considered interns. The availability of interns, i.e. effective short-term employees, allows better human resource management.

Internships as part of the educational program helps institutions in keeping track of students' levels and quality of involvement, achievement, and satisfaction. Outcomes of such metrics, in addition to SLO-related metrics can benefit universities first, by uncovering gaps in the material presented to students, if any. The same numbers can also be used by the industry to expose students' shortfalls as well as success in any area, serving as an additional factor in the filtering process and aiding employability-related decisions.

2.6. SOCIAL ASPECT

Bourdieu and Passeron (1979) state that social factors and predispositions impact every aspect of students' experiences; however, in the employability process, human variables such as gender, ethnic group, citizenship, home state, and social class tend to be overlooked. The sociology of students' experiences is often disregarded when evaluating their employability (James, 1995). This means that employability is possibly decontextualized (like the internship evaluation process), overlooking the impact of these factors and how they interact with labor market opportunities, in addition to the economic context and the availability of employment. The human variables can be the subject of a similar study, with an emphasis on evaluating the variance in scoring and industry suggested grade that is accounted for by the model. The purpose would not be to assess the responsibility of academic institutions or host companies, if the means of measurement are considered reliable, but only to measure the variance in performance accounted for by the human variables.

2.6.1. Employability

National survey-based data provides insight on the occupational distribution, work activities and career pathways of engineering students. Connections to education and the implication it has on choices made by the students are yet to be investigated. Knowing that the demand for engineering skills is greater than that of engineering occupations alone (ASEE 2017), there is a growing need to integrate and explore data collected by the academic enterprise to better understand trajectories of construction graduates. This can be achieved by combining existing data from the industry/agencies reports to datasets developed by universities which include educational variables as well as training (internships) and pathway outcomes (career choice of sector). Yoder states in the 2017 ASEE report that “migration patterns and student retention” in engineering can clarify and explain employment dynamics of construction students.

Lent et al. (1994) have developed a diagram, adapted and briefly summarized in Figure 2.8, that establishes a relationship between personal predispositions (contextual inputs) of an individual and the interests/career choice ultimately made. This emphasizes the importance of including these variables in the equation later on when the analysis starts and correlations are being established.

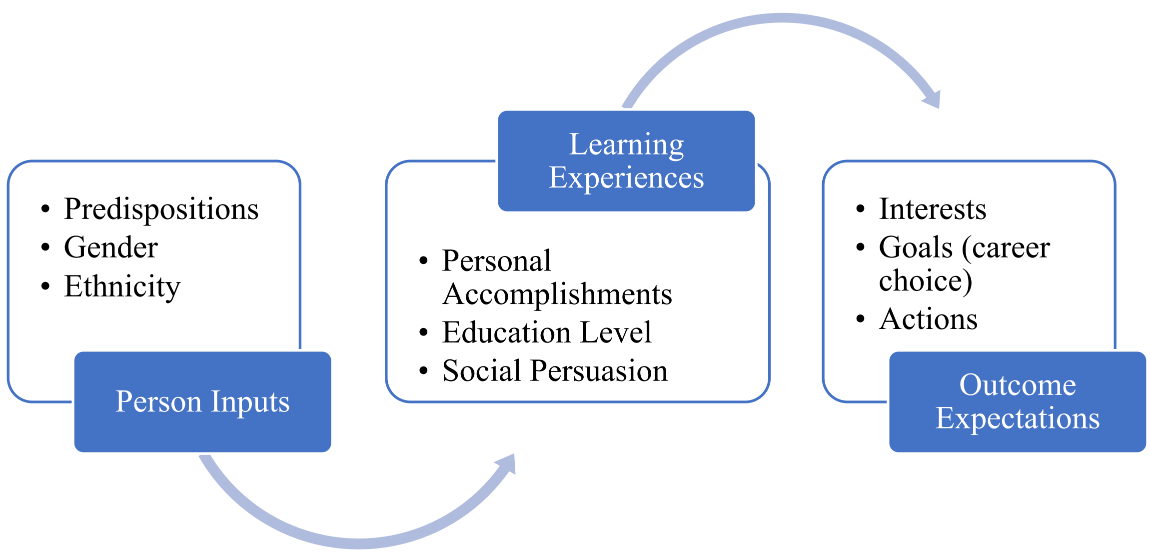

Figure 2.8. Diagram Linking Student’s Person Inputs to Outcomes [Adapted from Lent et al. (1994)]

The diagram shows a direct link between *Person* Inputs and *Learning Experiences*, which then relates to outcomes and actions made toward a career choice. A major challenge in this study would be an ethical one, since federal regulations protect the privacy of individuals involved against any disclosure of sensitive (personal) data which includes personal information.

2.6.2. Data Analysis

The aim from this section is to attempt to validate the literature concerning factors impacting employability and discussed in this section, i.e. human predispositions and sector choice. The dataset that is used to conduct the analysis includes performance results in particular areas, where companies grade students from the School of Sustainable Engineering and the Built Environment, ASU, who have completed an internship between 2012 and 2017. The sample includes 1127 former students in both classes CON 296 *Summer Field Internship* and CON 484 *Internship*, both mandatory as part of the graduation requirement in. While CON 296 is required to be predominantly field work, CON 484 can be either field or office. The longitudinal nature of the dataset (7 years) will help with making the individuals unidentifiable. The data has been collected through the years from the survey designed in conjunction with the American Council for Construction Education and the construction industry – the survey sent out to the companies is attached to the internship application.

Since the study involved humans as subjects, the research objective and method needed approval from ASU's Institutional Review Board (IRB). The IRB determined that the protocol is considered exempt, considering the educational settings, and the nature of the tests/surveys.

Table 2.2 shows each variable considered as explanatory in the data analysis, with the available values.

Table 2.2. Independent Variables Considered in the Data Analysis

Nb.	**Variable**	**Values**
1	Course level	Sophomore, senior
2	Gender	Male, Female
3	Ethnic Group	Native American, Hispanic, White, African American, Asian, Two or more races
4	Home state	AK, AZ, CA, CO, DE, FL, IA, IL, IN, KS, MA, MN, NC, ND, NE, NH, NJ, NM, NV, OH, PA, SD, TX, UT, VA, VT, WA.
5	Military status	Yes, No
6	Marital status	Married, Single
7	Sector	Commercial, Residential, Heavy civil, Subcontractor, Engineering, Owner, Consultant

The survey used for data collection includes an industry suggested grade, described as follows: “what grade would you give your student intern?” The industry suggested grade represents the overall performance of the intern during the internship and is ranked by the direct evaluator in the host company. This section investigates the correlations between the suggested grade received from the company with student predispositions, in order to develop an understanding of the impact that social-related variables have on the performance of a student in the industry, if any, and whether it is a choice of sector or employability in the chosen sector. A power analysis conducted on the dataset used in this study showed that the sample size is acceptable, considering the nature of the variables accounted for. Table 2.3 shows the correlation coefficients between the choice of sector and the industry suggested grade.

The correlation coefficients between sectors and suggested grade, presented in table 2.3, does not show any statistically significance for most sectors. And when it does, for *subcontractor* and *owner*, the value is close to zero. Conducting an ANOVA test also revealed no statistically significant relationship for the same sectors, and a very small effect size for the ones that did.

Table 2.3. Correlation Coefficients Between Suggested Grade and Company Sector

Sector	Correlation with Suggested grade
Commercial	0.07*
Residential	0.005
Heavy Civil	0.044
Subcontractor	-0.093*
Engineering	0.022
Owner	0.09*
Consultant	-0.025

**Correlation is significant at alpha = 0.05*

Another ANOVA test was computed on the same sample to compare means between different ethnic groups in order to evaluate the statistical significance of this variable's effect on the suggested grade. The results showed a small effect size, according to Cohen (1988), for the subgroup *Native American*, with the highest effect size between all subgroups of 0.027 and a p-value of 0.64. All other groups had an effect size lower than 0.01 with p-values higher than 0.05. This does not go directly against the findings from the literature.

Findings from this study confirm that even if social factors and predispositions have been shown to impact students' industry experiences in the past (Bourdieu and Passeron 1979; James 1995), their performance is not impacted. The ANOVA test also showed no statistical significance between males and females when comparing means of suggested grades.

In summary, the results indicate that there are no statistically significant differences between the suggested grade received by individuals belonging to different ethnic groups and gender, or their choice of sector. Limitations to be considered regarding other variables such as marital status, military status, home state, and age, include the small subsample sizes corresponding to these subgroups.

Achievements, skills, and environmental factors (company culture, given tasks during internship, etc.) can all play a role in a students' future employability, and can be further examined. This also raises the question of economic situation and its impact on the construction industry and the availability of positions offered in the host company – as evidenced by the commercial sector currently attracting the highest number of student interns.

2.6.3. Need for Leadership

Dee Fink's taxonomy of significant learning emphasized the Human Dimension as well as Caring characteristics, both essential for the interactive nature of the taxonomy to exist. These are characteristics associated with construction leadership behavior (Butler and Chinowsky, 2006). Experiential learning helped developing students as individuals and more importantly as leaders (Ryan and Cassidy, 1996). Individuals who completed internships developed considerable critical thinking skills, they showed improvement in weighting options and challenging previously held ideas (Jones and Abes, 2004, p. 162). These skills developed in the industry increased students' creativity in solving problems and coming to conclusions. Leadership development consists of developing the individual as well as the community; both were found to benefit from experiential learning, suggesting positive impact on cognitive outcomes, and more importantly on leadership related characteristics such as attitude, moral, social, and personal results.

Methods of teaching leadership need to be broadened and thought of as a process in order to be effective and positively impact social change (Zimmerman et al, 2000). Leadership development is key for workforce development, as part of higher education.

Leadership development is changing. Fulmer (1997) states that organizations are always looking for innovative ideas and different techniques for learning leadership in order to keep up with the competition in today's economy. Institutions of higher education can achieve the desired methods of leadership development and make a difference in the leadership skills of next generations of students through internships and other experiential learning projects (Day 2000). Day continues by explaining that classrooms are not the only place to do that; the focus should be on specially designed programs, such as mandatory internships in accredited industry partners. Internships is believed to be an essential part of higher education, by bridging students' academic coursework with their careers (Roberts and Ullom, 1989).

Mission and vision of higher education institutions are most likely to change from preparing student for careers to embracing the idea of transforming students for life, as citizens conscientious and accountable, with respect to ethics and code of conduct (Bringle and Hatcher 1996). These institutions have the ability to implement an interdisciplinary and team-oriented approach in their students' lives, engaging with the industry they are learning and benefiting from what it has to offer. In studying 10 cases of leadership development, Bringle and Hatcher (1996), concluded that experiential learning in the industry helps creating learning communities in all areas of higher education, which supports campus and community assets. Experiential learning, through internships, helps increasing the students' interest in the subject, being able to relate and interact with the teacher. Higher education institutions can benefit from such co-curricular activities to enhance classroom performance (Stefes 2004).

Experiential learning is an essential part of education for construction students. With the growing need of skilled professionals in the construction industry, workforce development processes consider leadership skills as well as technical and soft skills. All of which can be developed not only in classrooms but more importantly during experiences, such as internships that occur in proper experimental learning environments.

2.7. CONCLUSIONS

This chapter has recognized and described the overarching theories of learning. The literature emphasized the importance of the learning environment in addition to identifying learners' preferred style, to maximize the learning experience. The intern is placed in the center of the partnership between the academic institution and the host companies, a position where Dee Fink's significant learning concept can be achieved. The last section of the chapter also elaborated the need for leadership education in construction to underline the necessity of developing soft skills. Human variables were addressed in the literature review, regarding the impact of predispositions on student employability. Therefore, a statistical analysis was conducted to evaluate the effect size of variables such as ethnic groups, gender, age, marital status, military status, and sector choice, on the performance of students in the industry. The results showed that there is no statistical significance related to the considered subgroups when it comes to student performance in the industry – shown in the dataset by the *suggested grades*.

In construction education, it is necessary to judge whether and how well students learned the explained material, in addition to evaluating if an instructional program has met its educational objectives (Felder and Brent, 2004). A report from the Accreditation Board of Engineering and Technology (2010) on the Basics of Accreditation states that it is also important to judge whether and how well students have mastered a skill related to the field of study and necessary for performing on the job. A two-step process is used to make a rational judgement on the matter, as proposed by Felder and Brent (2004). The first step is the assessment, deciding on the data that is needed for the second step and the procedure to obtain data. The second step is the evaluation, using the outcomes of the assessment to draw inferences. To address the two-step process, the next chapter will rely on surveys completed by the industry, where direct evaluators score student performance during internships, measuring quality of work, safety, as well as soft skills.

CHAPTER 3

EXPLORING CORRELATIONS BASED ON INTERNS DEMOGRAPHICS IN THE CONSTRUCTION INDUSTRY

3.1. ABSTRACT

Professional success is rarely predicted by academic attainment. This is due to the infinite number of factors that impact employability. The lack of consistent correlation between academic and professional success can be explained by industry valued skills that are often not covered by the traditional curriculum. The essential skillset required of a graduate entering the market today include interpersonal and soft skills. Employers are expecting higher levels from their graduate recruits, and the Accreditation Board for Engineering and Technology included these non-technical skills as part of the criteria of accreditation. Internships provide the environment required for learners to benefit the most from experiential learning, and offer a suitable setting for assessing the skills in question. This study investigates industry valued skills by conducting an exploratory analysis on the student demographics in the construction industry. Data is collected form surveys in accordance with the American Council for Construction Education's Student Learning Outcomes, completed by the industry as part of student internship evaluations. The study modeled student performance based on skills identified as highest predictors of student performance in the industry, and found the highest predictors to be*: ingenuity and creativity, punctuality and attendance, and initiative*. The findings helped create a prognostic model to predict the student performance; however, fitting the suggested grade data into a multivariate linear regression model did not provide reliable results. The study

shows the importance of controlling for elements influencing the experience, to enhance the quality of the statistical tests.

3.2. INTRODUCTION AND OBJECTIVE

Employers are interested in recruiting individuals with technical as well as contemporary and interdisciplinary abilities (Yaacoub et al. 2011). University programs are not effectively adapting to the rapidly changing expectations of engineering graduates (Graham et al. 2009). Consequently, there is a gap between what is expected from engineers entering the job market and the actual skills they possess. Although applied projects have been implemented as a means of refining teamwork abilities as well as providing practical experience (Dutson et al. 1997), they do not have all the necessary components of working in the profession. Baily (2017) explains that internships have been used to bridge the gap between education and the engineering profession, providing professional practice in addition to broadening of perspectives regarding the various areas of an engineering project. Additional learning outcomes create well-rounded professionals who can analyze a project's impacts from myriad new and different frames of reference that would not be present otherwise (Dukhan et al. 2008).

Construction employment is expected to grow by 12.9% between 2014 and 2024, with 790,400 jobs likely to be added, according to the employment projections generated biennially by the U.S. Bureau of Labor Statistics (BLS). Employment in industries such as manufacturing and agriculture is expected to decline by 6.7% and 5.2% respectively, as seen in Figure 3.1, which involves a loss of more than one million jobs over the ten-year period. Other industries have a growth rate that very between 2.9% (transportation) and 9.9% (services). In contrast the growth rate in construction is predicted to be one of the highest of all industries and twice the overall average growth (6.5%).

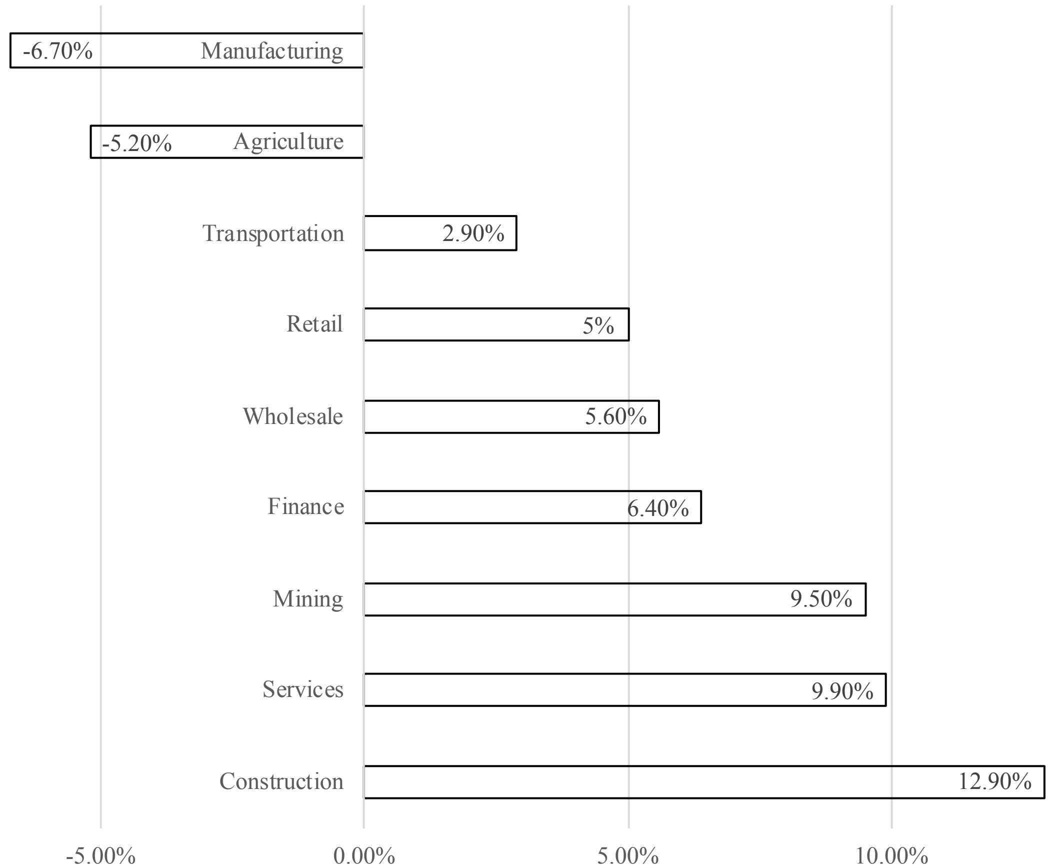

Figure 3.1. Construction Industry Showing the Largest Employment Need

The growing employment opportunity in the construction industry requires knowledge on a national level about the market, from an availability stand-point as well as skills and knowledge of new generations that are expected to fill the soon to be open positions. The American Society for Engineering Education (ASEE) provides insight on enrollment and degrees obtained in universities from engineering programs including civil and environmental programs, shown in Figure 3.1. The most recent ASEE report states that from a total of 124,477 Engineering Bachelor’s degrees awarded in 2017, 11,920 are in Civil, and 1,301 are in Environmental Engineering. From a total of 64,602 Master’s degrees awarded in all Engineering programs, 4,977 are civil engineering degrees, and

867 are in Environmental. The report also shows doctoral degrees earned the mentioned programs in 2017, where 855 and 187 are respectively in Civil and Environmental, from a total of 11,589 degrees. Academic achievement levels of the students, seen in Figure 3.2, are the only metrics that the industry relies on in a traditional employment process. This study aims to investigate the construction industry valued skills, by performing an exploratory analysis on survey results.

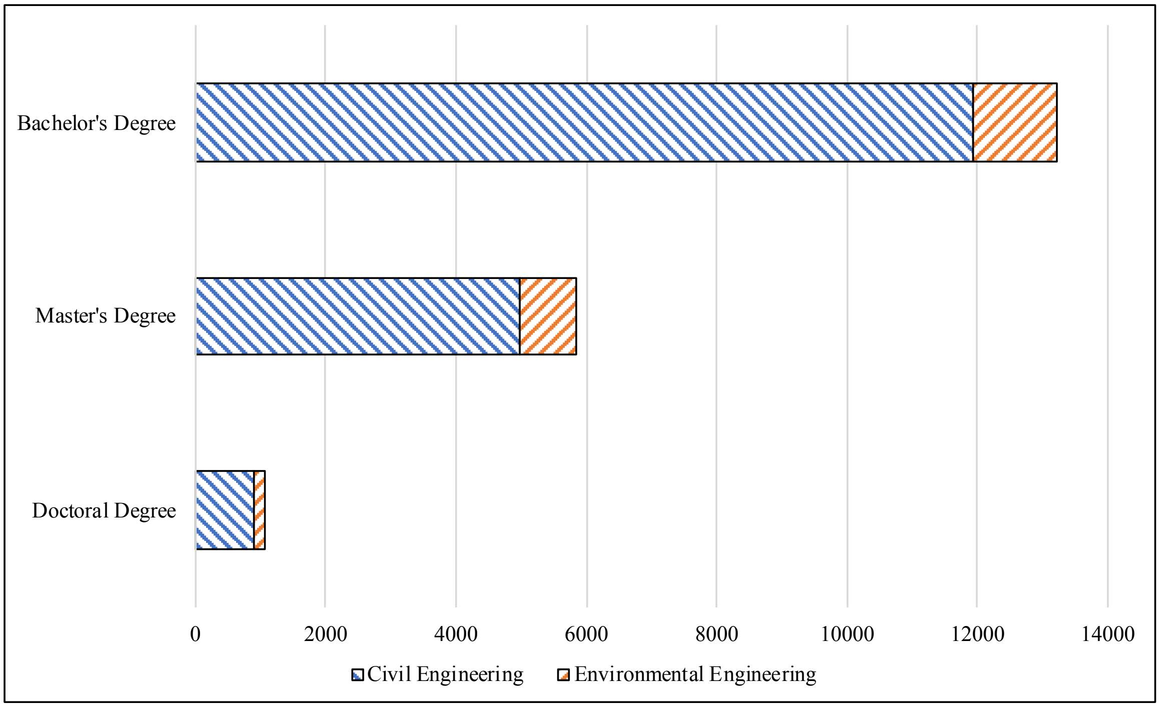

Figure 3.2. Degrees Awarded by Engineering Programs in 2017

The purpose is to better understand the skills needed by the students, thus required by the academic unit. This chapter compares interns' scores – graded by the industry – and students' overall performance on the job, to attempt generating a predictive model from the relationship between the variables. This chapter suggests an approach which looks at internships as a framework that combines the two aspects and sets the outline for better comparison between the two without factoring in independent variables associated with employment such as economic situation or availability of positions.

3.3. RESEARCH METHODOLOGY

With the growing construction industry, there is a growing need for skilled professional. Recent data in the STEM fields, construction in particular, with an approach on education is presented first, as shown in Figure 3.3. Then, demographics of student interns will be investigated using data from a survey conducted by the school and completed by the industry. The questions in the survey presented later on will include Student Learning Objectives (SLOs) as defined by the American Council for Construction Education (ACCE, 2013). Questions are answered by the industry (direct evaluator from the company selected by the student), following the completion of the program's mandatory internship. Next, the results will be analyzed to examine correlations with student variables that vary from human data (ethnicity, citizenship, age, etc.) to academic efficacy/achievement dynamics (final grade, level of education, journal, etc.). The surveys correspond to student enrolled between 2012 and 2018. Highest predictors of student overall performance in the construction industry are identified and used to generate a predictive model, followed by comments on the reliability of the model.

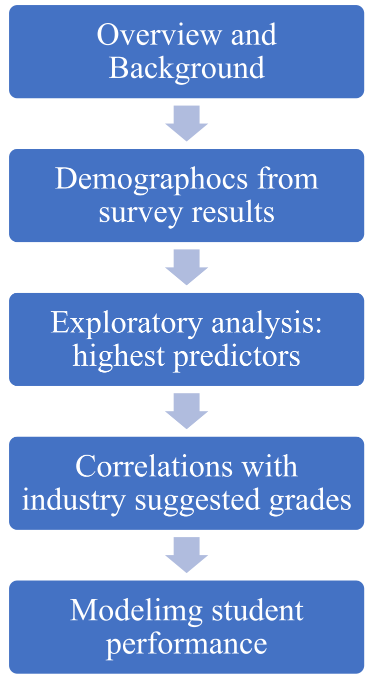

Figure 3.3. Research Methodology

3.4. ADMINISTRATIVE DATA

National survey-based data provides insight on the occupational distribution, work activities and career pathways of engineering students; however, connections to education and the implication it has on the choices made by the students are yet to be investigated. Knowing that the demand for engineering skills is greater than that of engineering occupations alone (ASSE 2018), there is a growing need to integrate and explore data collected by the academic enterprise to better understand trajectories of construction graduates. This can be achieved by combining existing data from the industry/agencies reports to datasets developed by universities which include educational variables as well as training (internships) and pathway outcomes (career choice of sector). "Migration patterns and student retention" in engineering can clarify and explain employment dynamics of construction students.

3.4.1. Overview of Current Numbers

Out of 12 occupations in engineering, as specified by the National Academy of Science, Civil Engineering is ranked 9th in gender diversity, 9th in the number of White professionals and 8th in the umber Asian professionals. 18.1% of total number of graduated engineers hold a bachelor degree in Civil Engineering. The same report shows that almost 40% of Bachelors continued to earn a Master's degree and more than 9% pursued a PhD track. The total percentage of Bachelor degree holders who joined the Engineering workforce is around 50%. That indicates half of the workforce added every year being educated yet inexperienced. Table 3.1 gives more insight on demographics of engineering professionals in the U.S., based on data reported by the national science foundation (2015).

Arizona State University (ASU) holds the highest number of undergraduate enrollments, 11,572 students in 2015 according to the American Society for Engineering Education (ASEE). The school of Engineering falls to the third place in terms of graduate studies with 1212 Masters awarded between 2006 and 2015; therefore, ASU has the highest contribution of bachelor degrees to the workforce.

Table 3.1. Demographics of Engineering Professionals in the U.S. (NSF, 2015)

	Male	Female	Asian	Alaska Native	African American	Hispanic	Pacific Islander	White	More than one race
All Occupations	85.50%	14.50%	16.20%	0.20%	4.30%	7.00%	0.20%	70.60%	1.60%
Aerospace	87.50%	12.50%	12.50%	C	2.10%	11.50%	C	70.80%	C
Biomedical	73.10%	26.90%	15.40%	C	3.80%	7.70%	C	73.10%	C
Chemical	78.80%	22.50%	16.30%	C	C	5.00%	2.50%	73.80%	2.50%
Civil	80.50%	19.50%	14.70%	C	4.40%	8.00%	C	70.10%	2.00%
Computer	92.90%	7.10%	34.30%	C	1.40%	5.70%	C	57.10%	C
Electrical	89.90%	10.70%	21.40%	C	5.50%	7.20%	0.30%	64.10%	1.40%
Environmental	66.70%	33.30%	9.10%	C	6.10%	6.10%	C	74.20%	C
Industrial	81.70%	18.30%	15.90%	C	8.50%	8.50%	C	67.10%	C
Materials	83.90%	16.10%	9.70%	C	C	6.50%	C	74.20%	C
Mechanical	91.70%	8.60%	13.60%	C	3.60%	5.60%	0.30%	75.70%	1.50%
Petroleum	89.50%	10.50%	15.80%	C	C	5.30%	C	73.70%	C
Postsecondary	84.90%	15.10%	30.20%	C	1.90%	5.70%	C	60.40%	C

**C: number is censored by the source because it is too small to report*

3.4.2. Diversity Challenge in the Industry

The National Academy of Science report shows that White and Asian males represent the majority of degreed engineers and who work in engineering occupations. Minority populations are underrepresented among engineering degree earners and in the engineering workforce. This is the same in the construction industry. For example, women represent more than half of the United States college-educated workforce; however, in 2013, women accounted for almost 15 percent of those who work in construction. The same report also shows that women and men have similar retention rates in undergraduate degree programs, but women are more likely than men to switch to another STEM field. Figures 3.4, 3.5, and 3.6 show student enrollment percentages of females and males in bachelor's, master's and doctoral construction programs, respectively.

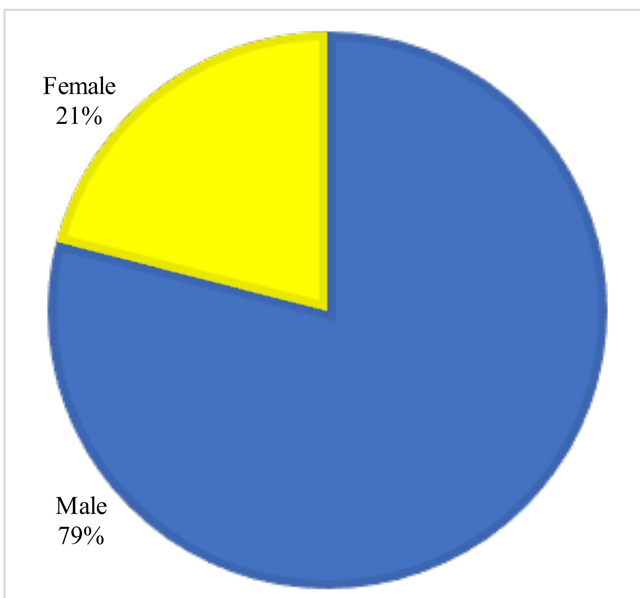

Figure 3.4. Percentage of Enrollment in Construction Bachelor's Programs, by Gender.

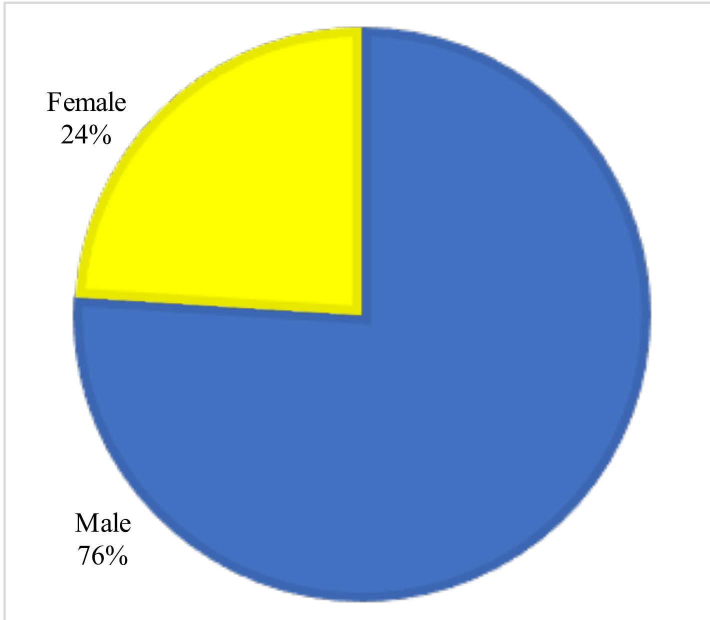

Figure 3.5. Student Enrollment in Construction Master's Programs, by Gender.

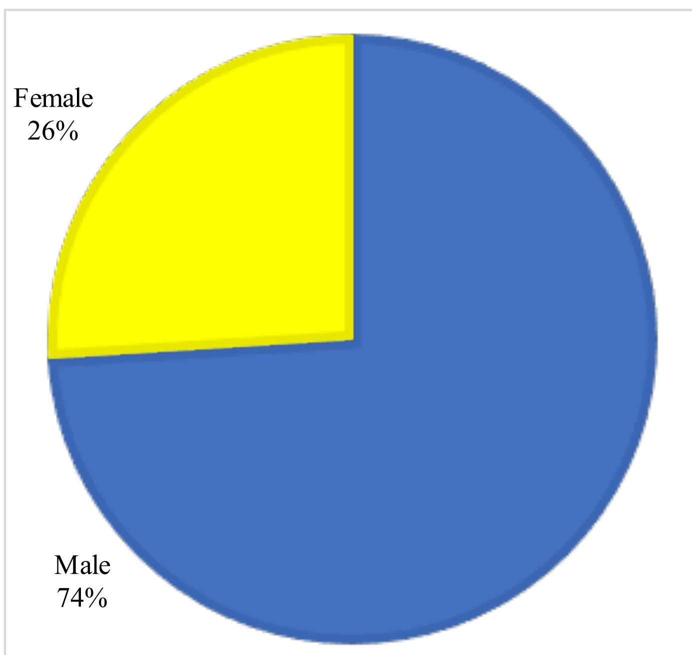

Figure 3.6. Percentage of Enrollment in Construction Doctoral Programs, by Gender.

Ratios are even smaller for other minority groups such as Hispanics and African Americans. Diversity in academic enrollment also represents the same situation, even with outreach effort are being made to stimulate minorities to join construction programs. Figures 3.7, 3.8, and 3.9 show the percentages corresponding to ethnic groups in terms of enrollment in bachelor's, master's, and doctoral construction programs, respectively. The numbers represent U.S. citizens alone, without accounting for international student enrollment, to better visualize the local situation.

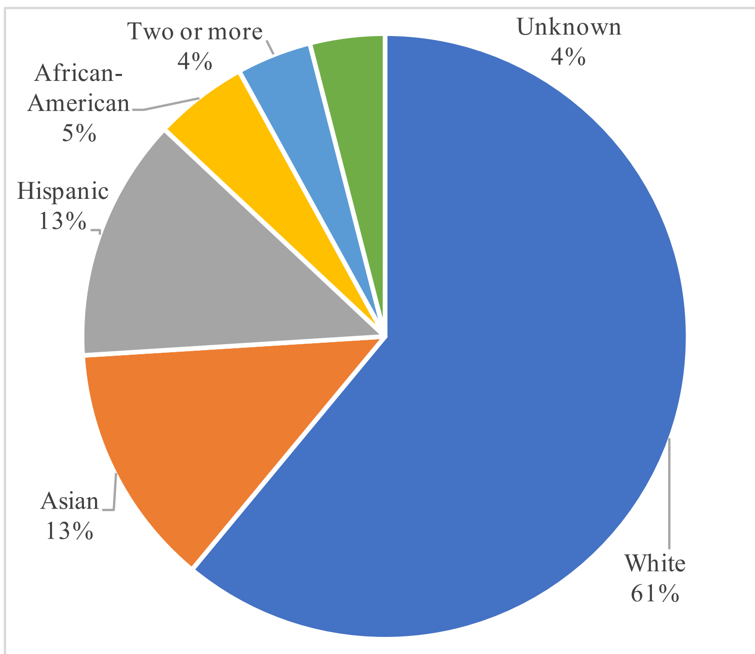

Figure 3.7. Percentage of Enrollment in Bachelor's Construction Programs, by Ethnicity.

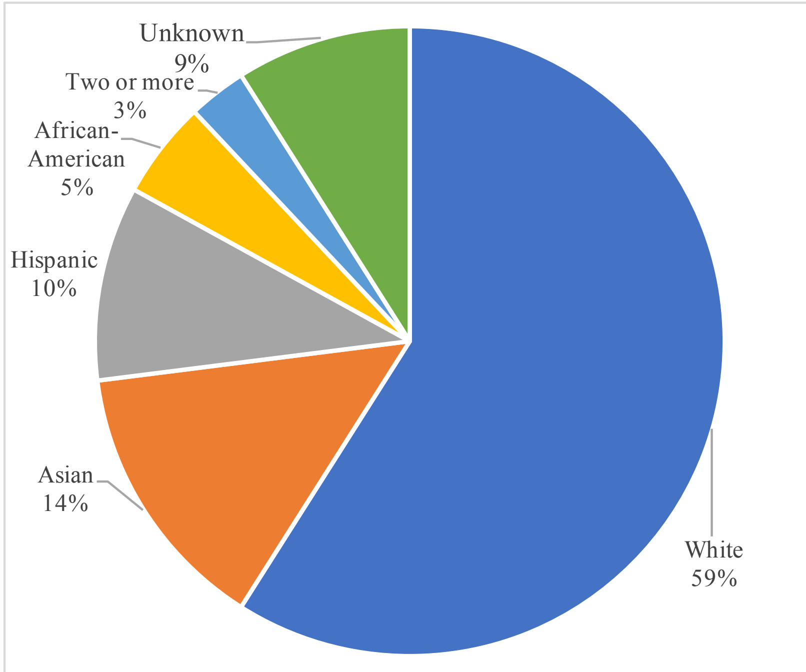

Figure 3.8. Percentage of Enrollment in Master's Construction Programs, by Ethnicity.

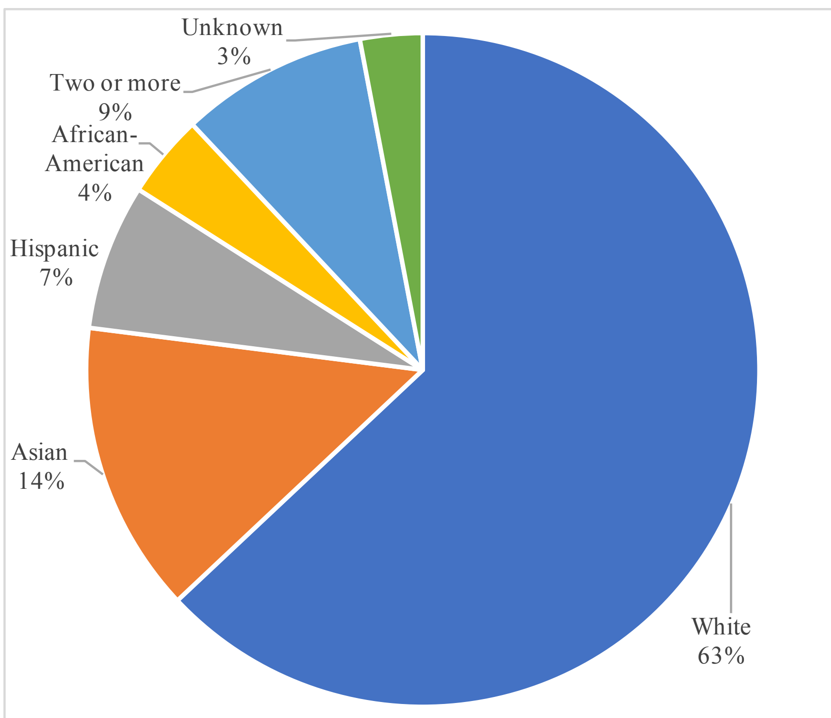

Figure 3.9. Percentage of Enrollment in Doctoral Construction Programs, by Ethnicity.

International students have constituted a large share of engineering school enrollments at the graduate level in the United States. Numbers in ASU follow this national trend. However, the growth of foreign student enrollments in undergraduate engineering programs is a more recent development. This led to a lack of analyzed data on undergraduates, which makes the need for the survey presented in this paper more critical, since it includes students in their second and/or fourth year of construction program. The factors of the increasing number and its impact on host universities as well as the industry are yet to be examined.

3.5. SURVEY

According to Freeman et al (2014), a meta-analysis computed on active learning in STEM programs showed that student performance increases with active learning. Construction students can only move through quadrants by being involved and starting their experiential journey along their education, which will allow educational institutions to keep track and analyze results from both sources (academic and experiential) to better understand trends and evolution of their students. This explains the need of acquiring and exploring data from surveys, where the industry, more specifically a direct evaluator in the company, grades students' performance in order to relate results with academic achievement.

The Construction Industry Advisory Council of the Del E. Webb School of Construction at ASU requested in 1999 the creation of a mandatory internship as part of the graduation requirement. The "field internship" was offered as two classes: CON 484 and CON 296, requiring 320 hours of work with 32 hourly pay weeks. In addition to written reports by the students, internship deliverables included a survey upon completion, completed by the supervisor and covering ACCE SLOs.

Over the course of months, students from the Construction school are deeply involved in construction site responsibilities as well as construction services related tasks. The purpose of this internship is to provide those students who have an interest in pursuing a career in the construction with the opportunity to apply the theories, tools and techniques learned in the classroom, to actual operational situations, under the guidance of a company manager. The undergraduate student should be involved in several operations such as estimating, scheduling, project management. to advance skills, to develop a "real world" perspective and to get a comprehensive view of company functions. This is in contrast to traditional internships, in which student engineers are given fewer responsibilities and in turn fewer opportunities to grow professionally.

Feedback from the industry presented to the school regarding students' need of internships were:

- Opportunity for industry to identify individual strengths and weaknesses of each student; significant attitudinal challenges could be addressed prior to graduation.
- Industry feedback can be provided to faculty for curriculum considerations and improvements. For example, re-introducing a plan reading class back into the curriculum were both a result of feedback from internships
- Adjustments can be made to the student experience. For example, changing the OSHA 10-hour to 30-hour.

- Industry tendencies and preferences among student intern cohorts can be identified. This information can better prepare students for interviews and future internship experiences.

3.5.1. IRB Process and Data Collection

The dataset will include performance results in particular areas, where the companies grade students from the School of Sustainable Engineering and the Built Environment, ASU, who have completed an internship between 2012 and 2018. The sample includes students that are former students in the classes CON 296 *Summer Field Internship* and CON 484 *Internship*, both mandatory as part of the graduation requirement. The longitudinal nature of the dataset (7 years) will help with making the individuals unidentifiable. The data has been collected through the years from a survey designed in conjunction with the American Council for Construction Education and the construction industry – the survey sent out to the companies is attached to the internship application. Since the study involved humans as subjects, the research objective and method needed approval from ASU's Institutional Review Board (IRB). The IRB determined that the protocol is considered exempt, considering the educational settings and the nature of the tests/surveys.

Fifteen questions were presented in the survey, covering both the behavior of the interns and their productivity, based on SLOs description until 2017. Table 3.2 shows each question as presented in the survey, with a brief explanation of the question as shown in the survey.

Table 3.2. Description of Survey Questions

Nb.	Question	Description
1	Punctuality and Attendance	Arrives to work on time, every day.
2	Dependability	Carries out instructions effectively and meets commitments.
3	Time management	Efficiently schedules tasks and completes on time.
4	Attitude, enthusiasm	Consistently displays a positive outlook towards work.
5	Productivity	Effectively uses time and energy to complete tasks.
6	Quality of work	Ensures project quality by producing consistent error-free work.
7	Judgment	Comes to reasonable conclusions based on logical assumptions.
8	Ingenuity, creativity	Generates creative solutions and develop better ways to perform tasks.
9	Adaptability, versatility	Adapts behaviors and methods to ensure project success.
10	Oral communication	Clearly conveys a verbal message and have it understood by the listener.
11	Writing skills	Communicates ideas with proper organization, structure, and grammar.
12	Initiative	Demonstrates self-starter who needs little direction.
13	Humbleness	Conduct is unpretentious, modest, and without arrogance.
14	Safety	Implements OSHA safety standards appropriately in the work environment.
15	Productivity	For the internship.

Each question has a maximum possible score of 6, amounting to a total of 90. The total is computed to represent 25% of the total grade of the internship class, along with a suggested grade by the direct evaluator which also accounts for 25%. The remaining 50% is graded by the academic unit, which aims to evaluate the learning experience and the ability to report the performed tasks.

In order to verify the internal consistency of the survey, Cronbach's alpha is measured to show how closely related a set of items are (Shavelson 1981). The questions in the survey must have good internal consistency, which means that two questions from the survey cannot be measuring the same variable. This process removes redundancies in the questionnaire and allows to move further in the investigation. To test the quality of the survey question, the inter-item correlation is presented in table 3.3. Shavelson (1981) explains that consistent numbers in the table, here balanced around 0.5, show that consistency is achieved.

Table 3.3. Inter-Item Correlation Showing Survey Internal Consistency

	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**	**Q15**
Q1	1.0														
Q2	.64	1.0													
Q3	.54	.58	1.0												
Q4	.56	.54	.55	1.0											
Q5	.57	.53	.52	.55	1.0										
Q6	.53	.63	.78	.48	.63	1.0									
Q7	.56	.55	.61	.49	.57	.62	1.0								
Q8	.57	.54	.54	.41	.57	.55	.60	1.0							
Q9	.54	.58	.57	.54	.60	.59	.63	.58	1.0						
Q10	.63	.57	.54	.42	.54	.53	.58	.57	.58	1.0					
Q11	.60	.56	.57	.42	.57	.59	.57	.57	.58	.67	1.0				
Q12	.52	.59	.58	.47	.64	.53	.57	.59	.64	.54	.55	1.0			
Q13	.50	.53	.50	.55	.52	.49	.49	.41	.52	.41	.51	.48	1.0		
Q14	.67	.50	.49	.44	.57	.50	.49	.47	.49	.51	.55	.44	.53	1.0	
Q15	.58	.55	.49	.49	.57	.55	.54	.53	.59	.53	.57	.56	.51	.55	1.0

The survey was completed by the industry to reflect their opinion toward the students' performance. Data where a direct evaluator from the company are considered. Some companies included in the dataset are relatively small and the direct evaluator has normally a higher position, i.e. president or chief executive; the effect of the firm size and/or evaluator position will be the subject of future explorations.

3.5.2. Model Design and Power Analysis

After testing the internal consistency of the survey questions, another step was to show that the dataset used has enough power – in other words, if the sample size for each question is enough to project the results and sufficient to proceed with the study. The power test allows us to assess whether the test correctly rejects the null hypothesis when a specific alternative hypothesis is true. Following the regression analysis between all questions and the dependent variable (here "Total grade"), the dataset was proven to be exceedingly pertinent for the study. Total sample size is 1127 student interns between 2012 and 2017. However, it is important to note that each part of the analysis considers items that are available for the specific question and this results in different applicable sample sizes for any given question – this happens when the software used for the analysis excludes Not Applicable items in order to preserve the reliability of the results. An average sample size for each question in the exploratory analysis for this study will be 760 student interns, depending on the available and useful data for each question.

3.6. SURVEY RESULTS

This survey results include first descriptive on subgroups from the sample, with frequencies and percentages. Then an exploratory analysis will be conducted to examine correlations between variables, starting with a stepwise regression which allows to identify highest predictors of the dependent variable, followed by a multivariate linear regression model.

3.6.1. Descriptive Analysis

Tables 3.2 – 3.10 show preliminary descriptive results from the dataset, including frequencies and percentages of the presented subgroups.

Table 3.4. Number of Students, by Ethnicity

Ethnic Group	Frequency	Percent
Asian	32	2.8
Native American	48	4.3
Other	58	5.2
Hispanic/Latino	257	22.8
White	732	65.0
Total	1127	100.0

"Other" includes groups that have a percentage lower than 2%. These groups are African American, Native Alaska, Two or more, and Not available, with percentages of 1.6%, 0.4%, 1.9%, and 1.3%, respectively.

Table 3.5. Number of Students, by Gender

Gender	Frequency	Percent
Female	148	13.1
Male	979	86.9
Total	1127	100.0

Table 3.6 Number of Students, by Marital Status

Marital Status	Frequency	Percent
Married	3	0.3
Single	546	48.4
Unknow	578	51.3
Total	1127	100.0

Marital Status is an example of many variables that had negligible results once correlations were examined. Other variables include military service, term of admission, and home state. The lack of correlation can also be explained by the large number of unavailable data.

Table 3.7. Number of Students, by Home State

Home State	Frequency	Percent
AZ	837	74.3
CA	101	9.0
TX	23	2.0
NY	19	1.7
WA	19	1.7
NV	16	1.4
CO	11	1.0
NM	11	1.0
Others	78	8.0
Total	1127	100.0

Others include states with a number of students lower than 10. The list of the 22 other states is the following: AK, DE, FL, IA, ID, IL, IN, KS, MA, MN, NC, ND, NE, NH, NJ, OH, PA, SD, US, UT, VA, VT. Note that 93% of students (in and out of state) complete their internships in AZ.

Table 3.8 Number of Students in Each Sector

Sector	Frequency	Percent
Commercial	597	52.9
Heavy Civil	234	20.8
Subcontractor	177	15.7
Residential	55	4.9
Owner	36	3.2
Consulting	21	1.8
Engineering	8	0.7
Total	1127	100.0

The commercial sector, observing a more rapid growth in the industry, attracts the highest number of students with 597 interns compared to the closest following sector, heavy civil, with 234 interns.

While all the questions received high scores of 6, punctuality, attitude, *quality of work*, and *humbleness* received the lowest minimum values (lower than 3). Table 3.9 shows the descriptive of each question, with the minimum value, maximum value, average and standard deviation.

Table 3.9. Descriptive of Scores Received on All Questions

Number	Question	Minimum	Maximum	Average	Standard Deviation
1	Punctuality	1.50	6.00	5.62	0.75
2	Dependability	3.00	6.00	5.52	0.75
3	Time Management	3.00	6.00	5.34	0.81
4	Attitude	2.25	6.00	5.67	0.64
5	Productivity	3.00	6.00	5.36	0.83
6	Quality of Work	2.25	6.00	5.27	0.83
7	Judgment	3.75	6.00	5.25	0.84
8	Ingenuity	3.75	6.00	5.11	0.90
9	Adaptability	3.00	6.00	5.31	0.85
10	Oral Communication	4.50	6.00	5.23	0.86
11	Writing Skills	3.00	6.00	5.24	0.89
12	Initiative	3.00	6.00	5.22	0.95
13	Humbleness	2.25	6.00	5.60	0.74
14	Safety	3.00	6.00	5.51	0.79
15	Productivity	3.00	6.00	5.45	0.79
	Suggested Grade	2.00	4.00	3.88	0.49
	Evaluation Grade	36.00	50.00	47.85	3.16
	Total Grade	62.00*	100.0	88.05	16.26

** This value considers only grades of students who received a grade on their journal (50 possible points)*

When separated by gender, females received higher grades on 12 out of 15 questions, with the exception of punctuality (5.64 > 5.47), dependability (5.53 > 5.51), and safety (similar score of 5.51). Females also show a higher total grade of 91.45 compared to 87.55 for males. In terms of sector choice, females did not choose *Engineering* or *Mechanical Subcontractor*, with a zero turnout for internships in these sectors compared to 4 and 16 for males, respectively. Females have a higher percentage than males in *consulting* (2.7 > 0.7) and *owner*: (3.3 > 1.4). All other sectors show almost similar percentages in both genders. The payrate average is close between male and female interns, as shown in table 3.10, with a higher maximum value for females ($46.50 > $40.00). Values equal to $0.00 are unpaid internships.

Table 3.10. Payrate Received as Compensation for Internship, by Gender

Gender	**Sample**	**Minimum Payrate**	**Maximum Payrate**	**Average Payrate**
Female	144	$ 0.00	$ 46.50	$ 14.29
Male	950	$ 0.00	$ 40.00	$ 14.69

3.6.2. Exploratory Analysis

3.6.2.1. Stepwise regression: higher predictors of the dependent variable

Stepwise regression is a method of fitting a regression model by automatic procedure. (Cohen 1988). In each step, an independent variable is considered to be an addition to the set of predictors. R square represents the portion of the dependent variable that is explained by the independent variable in question, which is any question response from the survey that is included in the model (Cohen et al. 2003). To clarify, the bigger the value of the R square associated with an independent variable, the better it explains for the variance seen in the dependent variable. A p-value lower than 0.05 indicates statistical significance with an acceptable confidence interval where 95% of the population mean is contained. The results of the stepwise showed statistically significant correlations between creativity, punctuality, initiative, and the dependent variable. These variables are presented in the models explained in the next paragraph. Table 3.11 shows the R squared corresponding to each model reported by the stepwise regression, adding one predictor at a time, to achieve a higher value in model 3.

Table 3.11. Regression Model Summary

Model	**R Squared**	**P-value**
1	14.3	< 0.01
2	15.5	< 0.01
3	16.9	< 0.01

All models share the same dependent variable described in the previous paragraph, which is Total Grade received on the internship evaluation. The predictor considered in model 1 is question number 8 from the survey: Ingenuity and creativity of the student. The average of the responses to that question is 5.11. out of 6. Model 2 includes in addition to Ingenuity and creativity, responses to question number 1: Punctuality and attendance, with an average of 5.62 out of 6. Lastly, model 3 with the highest R2 also includes values received on question 12: Initiative, which had an average of 5.22 out of 6. The R2 for these three range between 14.3 and 16.9, with a p-value lower than 0.01. According to the regression analysis, these are the highest predictors of the total grade received on an internship. These skills play a major role in students' employment in the companies where they completed their internships. This confirms the individual development, discussed in the second section of this paper, expected from students to attain in an experiential learning environment such as internships. The survey results are validated in the literature, showing that a positive impact on cognitive outcomes was achieved by students demonstrating creativity, punctuality, and initiative.

3.6.2.2. Multivariate Linear Regression Modeling

A multivariate linear regression model describes the relationship between two or more continuous variables, by fitting a linear equation to the observed data. One variable is considered to be a dependent variable, and the other variables are considered explanatory variables. The multivariate linear regression modeling consists of analyzing the relationship between the variables, estimating the model (i.e., fitting the line) and evaluating its validity and usefulness. Since the regression in this study is used to predict the industry *suggested grade*, then the suggested grade is considered as the dependent variable. The regression model tests whether the factors explain the variability seen in the dependent variable. The factors considered in this study, which are the highest predictors identified earlier in the stepwise regression, will be considered as the independent variables; these are *Initiative*, *punctuality and attendance*, and *ingenuity and creativity*.

A correlation matrix shows the linear relationship between the considered variables, in order to examine multicollinearity issues, if any. The correlation matrix, as shown in Figure 3.10, does not present any strong linear correlation between any set of variables. The matrix does not suggest any issues to address before moving forward.

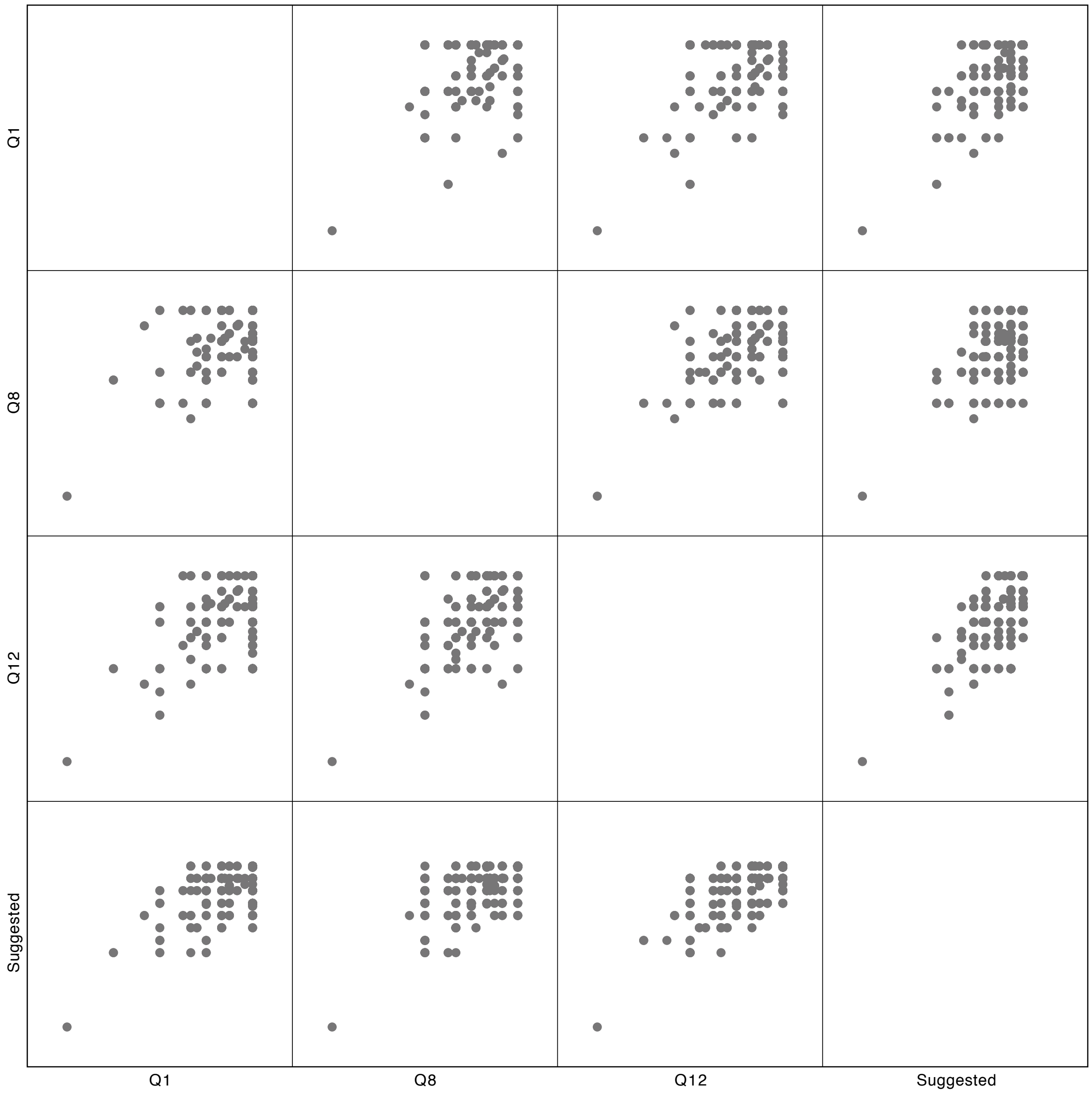

Figure 3.10. Correlation Matrix Showing no Strong Linear Correlation Between any Set of Variables, Validating Collinearity Assumption
(A strong linear correlation is characterized by the data points being closer to a straight line instead of dispersed in the plot.)

Table 3.12 shows correlation coefficients between all the considered different variables. Cohen (1988), best known for setting the foundations for effect size and statistical power, delimits correlation size between the three following thresholds: 0.1 – 0.3 for small correlation, 0.3 – 0.5 for moderate, and higher than 0.5 for large.

Table 3.12. Correlation Coefficients Between the Considered Variables

Variables	Initiative (Q12)	Punctuality and Attendance (Q1)	Ingenuity and Creativity (Q8)
Coefficient of correlation with *Suggested Grade*	0.606	0.508	0.530

The results from this study show a large correlation between the three considered variables and the industry suggested grade, ranging between 0.508 and 0.606.

Generally, the regression line equation is as follows: Predicted Y = $B_{XY}X + B_0$, where X is the corresponding value of the variable in question, B_{XY} is the slope of the regression line and represents the coefficient of X, and B_0 is the Y intercept. For a multiple regression model, the equation includes two or more X values with a coefficient B for each, as follows: Predicted Y = $B_1 X_1 + B_2X_2 + B_nX_n + B_0$. In other words, the formula accounts for all considered independent variables when examining the relationship with the dependent variable (Cohen et al 2003).

Fitting the suggested grade data into a multivariate linear regression model, knowing that all factors are significant with p-value lower than 0.01 and using the coefficients presented by the regression analysis, yields to the following formula:

$$Industry\ Suggested\ Grade = \begin{cases} 1.653 + \ 0.157\ Q1 + \\ 0.102\ Q8 + 0.161\ Q12 \end{cases}$$

The regression analysis result show a R squared of 0.45. R squared is a coefficient of determination and represents the amount of variations in the suggested grade that can be explained by the variables in the model. The standard error of the estimate shows the accuracy of the model, by determining the difference between the real observed values of the suggested grade and the values predicted by the model. In this case, the standard error of the estimate is equal to 0.33, which is a high value and shows that the model is not reliable enough to predict suggested grades from the available data. The ANOVA test showed a p-value lower than 0.01, suggesting that not all coefficients were equal to 0.

3.6.3. Limitations and Threats to Validity

Questions are based on SLOs which rely on industry needs. As a result, SLOs are modified accordingly and an updated survey with 26 questions will include additional question topic areas in future surveys: Electronic-based skills, Ethics, Construction documents, Cost estimates, Cost control and accounting, Surveying, Project delivery methods, Legal issues, Structural behavior, Electrical systems, Mechanical piping systems, Technical capability. Before completing the dataset with the values corresponding to these questions, the survey is not completely accurate. Future work will include analysis on correlations then comparison with previous results.

Other threats that should be considered include the generalizability of the results since the sample only represents a regional population within one local school. A sample which includes students from other universities in other cities can improve the representation of the population. This leads to explore another limitation which is the standardization of the evaluation process: detailed definitions of the values in the survey are needed to guarantee inter-rater reliability and allow evaluators to assess with more comfort and understanding of the selected and reported answers. Another threat is the fact that internships considered in this study are mandatory, which could have positive or negative effects on intern's attitude. Lastly, one of the biggest threats to validity for this study is related to the industry: motivations in the evaluator can play a major role in jeopardizing the results. If the company can benefit from retaining the student, they may feel inclined to rate the individual better. Motivators for companies can also be affected by the economic situation and the repercussions this has on the availability and/or need for new employment. This is seen for instance in the commercial sector which can benefit from employee retention. This also raises the question of uniform "consistent scores": these are grades of 100% on the evaluation, which are in majority in the commercial sector – more than 60% according to the survey results. The relationship here should be investigated in order to limit the impact of industry variables on the results. Evaluators in large companies are not always "direct evaluators", as it is discovered from students' journals. Some companies included in the dataset are relatively small and the evaluator normally holds higher position, i.e. president or chief executive; the effect of the firm size and/or evaluator position will also be the subject of future explorations.

3.7. CONCLUSIONS

Experiential learning is an essential part of education for construction students. With the growing need of skilled professionals in the construction industry, workforce development should consider exploring leadership skills as well as technical and soft skills, all of which can be developed during experiences (internships) that occur in a proper experimental learning environment. This study examined an exploratory approach to look at industry valued skills identified during student internships, by analyzing survey responses evaluating student performance. Questions in the survey are in accordance with the ACCE SLOs. The analysis findings showed that the highest predictors of student success in the industry are:

1) Question 12: *Initiative*
2) Question 8: *Ingenuity and creativity*
3) Question 1: *Punctuality and attendance*

This study aimed to present internships as a suitable framework to assess student performance. After generating a predictive model to calculate the dependent variable – industry suggested grade – the equation did not provide reliable results, indicating the need for more significant factors to be included in the model, as well as a larger sample.

The findings of a larger sample with more statistically significant factors correlated with the suggested grade can support decision makers in the employment process. In order to test student performance correctly, like any proper testing environment, elements influencing the experience have to be controlled. Cahn (1978) explains that the main factors that influence learning include motivation by the evaluator first, whether a learner is studying a specific subject or preparing for an evaluation. Then providing specific guidance and practice helps focusing student efforts. In other words, a specific setting has to be guaranteed to optimize student learning.

Factors such as *Company culture*, *Company size*, *Defined job description*, *Evaluator position (reviews)* can all threaten the accuracy and the validity of scores obtained on an evaluation in the industry, such as internship grades – which is used as basis to describe student performance in their first real-world industry experience. Moreover, Outside factors such as economy and need (availability) play a major role in the company's decision about retaining students as employees, thus possibly affecting their grading.

Threats to validity of the study are the focus of future research efforts.

CHAPTER 4

INDUSTRY GRADED INTERNSHIPS: CHALLENGES AND OPPORTUNITIES

4.1. ABSTRACT

Technical capabilities are often the decisive factor in assessing an individual's competencies. *Science of engineering* and *Practice of engineering* are two separate components of the technical competencies. While the first component can be taught and evaluated in class, the second one – *practice of engineering* – includes interpersonal skills which are accountable for achieving effective and high-performance results in a workplace. In order to evaluate student success in the industry, correct tools for measuring soft skills should be used in the correct environment. Mandatory internships in construction schools are suggested as an adequate framework for bridging the gap between learning and practicing levels. Internships provide the environment required for learners to benefit the most from experiential learning, thus offer a suitable setting for assessing the skills in question. Previous models evaluating student performance in the industry revealed challenges such as aligning evaluators on the measured value and keeping the evaluation objective and absent of direct company benefits. This study aims to address the challenges identified in the internship evaluation process. In order to do so, data was collected from surveys designed in accordance with the Student Learning Outcomes, and completed by the direct evaluators in the host companies. Results from analyzing the survey data showed that the highest predictors of student performance during internships are *dependability*, *productivity*, and *initiative*; in addition to *ingenuity, writing skills, and attitude* with a lower correlation coefficient. A predictive model based

on the newly identified predictors is computed; reliability results are compared to the previous model, showing a slight improvement. An Intra-Class Correlation (ICC) is computed to test the agreement between graders evaluating the same observation, and the results implied a lack of alignment between, denoting the need for a standardized rubric and scoring system. The survey is updated to meet recent SLOs, resulting in a form that includes 12 additional questions identified as needed skills by the industry, and offering more factors to be accounted for in future models – potentially improving the model's reliability. Lastly, the environment needed for a successful internship is described, followed by a discussion on the opportunities of a dynamic setting presented by internships in terms of cognitive development and skill measurement.

4.2. INTRODUCTION

Donhardt (2004) is one of many scholars who explained that student grades in college rarely predict professional success; correlation between the two is close to zero. Measurements used to assess success in each of these environments are drastically different. Previous studies have compared positions in a company, income, and final grade point averages. Differences become obvious when multiple factors out of control of the students, universities, and industry, play a major role in the tested correlation.

The correlation computed on the dataset used in this study between the interns' final grade on the internship course and their performance during the internship validate Donhardt's statement. The academic unit is assessing the students' experience based on elements of a written journal with a specific rubric, while direct evaluators in the host companies are observing behaviors and interacting with the students, gaining more insight on the essential soft skills needed on the job. This chapter aims to explores the threats to validity identified in the dataset, specifically the learning environment and the scoring system. The study first describes the difference between the measured skills in both environments – gain of knowledge in university setting as opposed to overall performance in the industry. Then a model is generated and compared to the first model created in the previous chapter, to evaluate the impact of one of the threats to validity. An inter class coefficient (ICC) will be computed to assess the agreement between industry evaluators scoring the same observation.

4.3. LITERATURE REVIEW

Outcomes-based accreditations for engineering programs have been of interest since the 1990s (Shaeiwitz, 1999). Programs are since accredited based on the knowledge and skills demonstrated by to the students rather than the number of hours of instruction. Sageev and Romanowski (2001) explain that while technical knowledge and skills are still the focus of most engineering programs, demonstrating that technical capabilities are often the decisive factor in assessing an individual's competencies in the industry., Technical competencies are divided between the "science of engineering" and the "practice of engineering", according to Martin et al. (2006). This means that the skills that are necessary for construction students to acquire during their years of higher education are not always properly evaluated. These competencies include recognizing problems and creating solutions, for example, which can be learned and improved only through experiential learning (Evans et al. 1993). This falls into the "practice engineering" area mentioned earlier. The "practice of engineering", according to Meier et al. (2000), is well demonstrated by the non-technical competencies, including communication skills and ethical attitude. Lang et al. (1999) emphasize the important role that these *interpersonal skills* play in terms of achieving effective and high-performance results in a workplace. The Accreditation Board for Engineering and Technology (2010) also encompasses the non-technical skills as part of the criteria of accreditation, since they fill competency gaps described by Holcombe (2003) as business, economic, or any other aspect that is not directly related to a technical construction task.

Employers believe that there is a lack of soft skills in the graduate job market, even when students achieve a high academic attainment (Ford, 2007). Firth (2011) addresses the same issue and concludes that employers are demanding higher levels from their recruits. This demand is directed to the accredited programs, as Hopp (2000) points out the responsibility of universities to hand off construction graduates who possess expert knowledge as well as critical thinking and understanding of the relationships between international, social, financial and technical aspects of the industry.

4.4. OBJECTIVE AND METHODOLOGY

In order to evaluate student success in the industry, soft skills as well as technical skills should be examined in the right environment, and using a precise scoring system. Mandatory internships in construction schools have been suggested as an adequate framework for bridging the gap between learning and practicing levels – defined by Bloom in 1965 and revisited by Anderson and Krathwohl (2003). Internships provide the environment required for learners to benefit the most from experiential learning, and offer a suitable setting for assessing the skills in question, according to Kolb (1987). Evaluating student performance in the industry revealed challenges such as:

- Aligning evaluators on the measured value
- Keeping the evaluation objective and absent of direct company benefits, such as retaining students by giving consistent full grades for recruiting needs
- Other employment-related factors such as availability, and economic situation

Skills are not easily defined, and there is a lack in the scientific means of measuring an individual's level in each skill, as Schulz (2008) clarifies the changing nature of each skill depending on the industry.

A predictive model was generated to give insight on student success in construction internships. Data was collected from surveys of 15 questions designed in accordance with the Student Learning Outcomes, as defined by the American Council for Construction Education (ACCE, 2007). The model validation results showed that it is not reliable, using the available sample and factors considered. This chapter aims to address the threats to validation identified. First, the model mentioned earlier is compiled again, excluding values that are considered as a threat to this study, in order to compare its reliability for predictive analysis to the previous model. Then, an Intra-Class Correlation (ICC) is computed to test the agreement between graders evaluating the same observation. Results from the ICC indicate the need for a standardized scoring system, which is developed based on the questions of the survey used in this study. The survey is updated to meet recent SLOs, resulting in a form of 26 questions also presented, offering more factors to be accounted for in future models, thus potentially more reliability. Kolb's experiential learning theory is described from the evaluator's standpoint, to emphasize the role of that person in each of the stages of the learning cycle. Lastly, a brief discussion on the experiential learning environment is presented, with suggestions for future research efforts.

4.5. EXPLORING THREATS TO VALIDITY

4.5.1. Modeling Student Performance

In contrast to previous studies, this section evaluates the reliability of the model generated without including consistent perfect scores in the sample, in order to assess the impact that these scores have on the predictive model. Consistent high scores are identified when a student receives the total grade on all questions (a total of 6 points on each of the 15 questions), in addition to a suggested grade of A+ on the industry evaluation form. These are especially questionable when they are provided to several students by the same evaluator or company, revealing potential benefits for the latter and affecting the scoring process. Table 3.1. shows the score difference between the original and the new datasets, in a letter grade format. The new dataset descriptive shows half a letter lower than the original dataset almost consistently.

Table 4.1. Difference in Scores Between Original and New Datasets

Nb.	Question	Original	New
1	Punctuality and Attendance	A	A-
2	Dependability	A	A-
3	Time management	A-	B+
4	Attitude, enthusiasm	A	A-
5	Productivity	A-	B+
6	Quality of work	B+	B
7	Judgment	B+	B
8	Ingenuity, creativity	B+	B-
9	Adaptability, versatility	B+	B
10	Oral communication	B+	B
11	Writing skills	B+	B
12	Initiative	B+	B
13	Humbleness	A-	A-
14	Safety	A-	A-
15	Productivity	A-	B+

The descriptive analysis conducted on the different sectors shows a high number of consistent scores in one sector more than others, as table 4.2 shows:

Table 4.2. Consistent High Scores, by Sector

Sector	Commercial	Heavy Civil	Subcontractor	Residential	Total
Frequency	168	4	10	2	184
Percentage from total students in this sector	31.2 %	8.3 %	4.6 %	0.9 %	100 %
Percentage from total students with perfect scores	91 %	2 %	5 %	1 %	100 %

A total of 184 perfect scores were identified in the dataset, which is 16.3% of the total number of students. This is not a surprising turnout; however, it is remarkable that 14.9% belong to the commercial sector alone. The commercial sector shows a significantly higher number of students with perfect scores (168) which represents 31.2% of the total students doing their internships in this sector, and 91% of the total students who received perfect scores. The high number and percentages corresponding to the commercial sector can be explained by the availability of positions and the need for recruitment in that growing sector, which potentially explains the need for attracting students, thus validating the threat that host companies can present to the survey results.

A stepwise regression computed using the new sample also shows a different list of highest predictors of student success in the internship program. Questions 2: *Dependability*; 4: *Attitude*; 5: *Productivity*; 8: *Ingenuity*; 11: *Writing skills*; and 12: *Initiative* are now the result of the stepwise regression, keeping questions 8 and 12 from the original model as part of the new model, and eliminating question 1: *punctuality and attendance*. It is also remarkable that question 12 *Initiative* remains in the top 3.

A correlation matrix shows the linear relationship between the considered variables, in order to examine multicollinearity issues, if any. The correlation matrix, as shown in Figure 4.1, does not present any strong linear correlation between any set of variables, validating the multicollinearity assumption; the matrix does not suggest any major issues to address before moving forward.

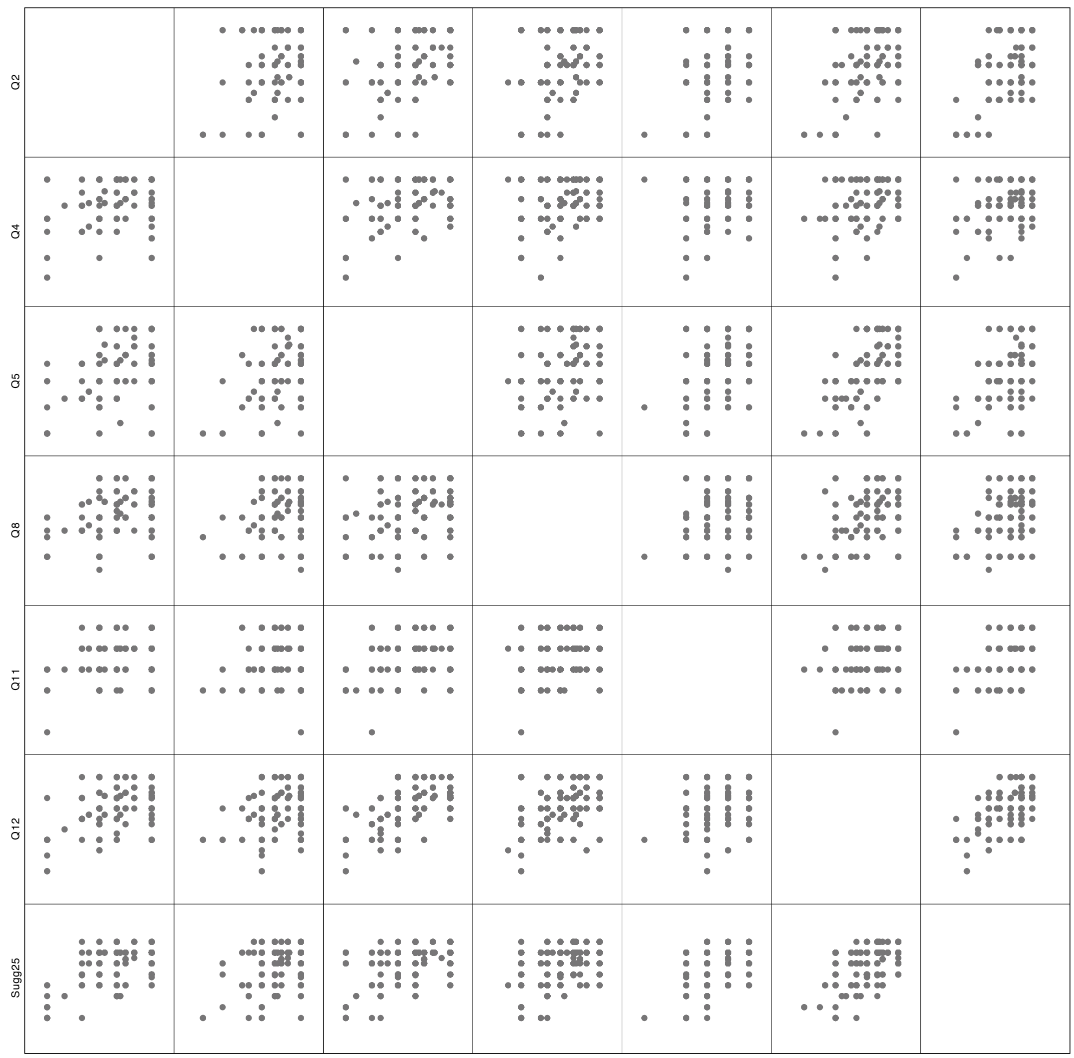

Figure 4.1. Correlation Matrix of the New Model Factors, Showing no Strong Linear Correlation Between any Set of Variables

Table 4.3 shows the correlation coefficients between all the considered variables in the model. The results from this study show a relatively medium correlation between *Attitude*, *Ingenuity*, and *Writing Skills*, with the dependent variable Suggested grade; along with large correlations between *Dependability*, *Productivity*, and *Initiative*, with the dependent variable (Cohen, 1988).

Table 4.3. Correlation Coefficients Between the Considered Variables

Variables	Dependability (Q2)	Attitude (Q4)	Productivity (Q5)	Ingenuity (Q8)	Writing Skills (Q11)	Initiative (Q12)
Coefficient of correlation with *Suggested Grade*	0.584	0.393	0.550	0.421	0.398	0.532

Cohen et al. (2003) explain the relationship between the independent variables and the dependent variable by a line equation, as follows: $Y = B_1 X_1 + B_2X_2 + B_nX_n + B_0$. Fitting the *suggested grade* data into a multivariate linear regression model, knowing that all factors are significant with p-value lower than 0.01 and using the coefficients presented by the regression analysis, yields to the following formula:

$$Industry\ Suggested\ Grade = \begin{cases} 6.081 + 1.159\ Q2 + \\ 0.496\ Q12 + 0.504\ Q8 + 0.516\ Q4 + 0.514\ Q5 + 0.289\ Q11 \end{cases}$$

The regression analysis result show a R squared of 0.44, which is similar to the value found in the previous model. R squared is a coefficient of determination and represents the amount of variations in the suggested grade that can be explained by the variables in the model. However, the standard error of the estimate is equal to 0.21 in the new model, showing that the accuracy of the model has improved, and the difference between the real observed values of *suggested grade* and the values predicted by the model is smaller than the previously developed model.

4.5.1.1. Experiential Learning and the Construction Environment

Another important factor is the role that the direct evaluator (*everyday mentor)* plays the correct role in order to give the ultimate opportunity for the student to benefit, in addition to accommodate the right activities and cater a better performance for the student, to ultimately evaluate accurately. The roles of the educator, in the case of the internship the direct evaluator, works around the learning cycle to provide the right environment, as seen in figure 4.2, for each of the styles (Kolb and Kolb, 2013): *The facilitator; The expert; The evaluator; The coach.*

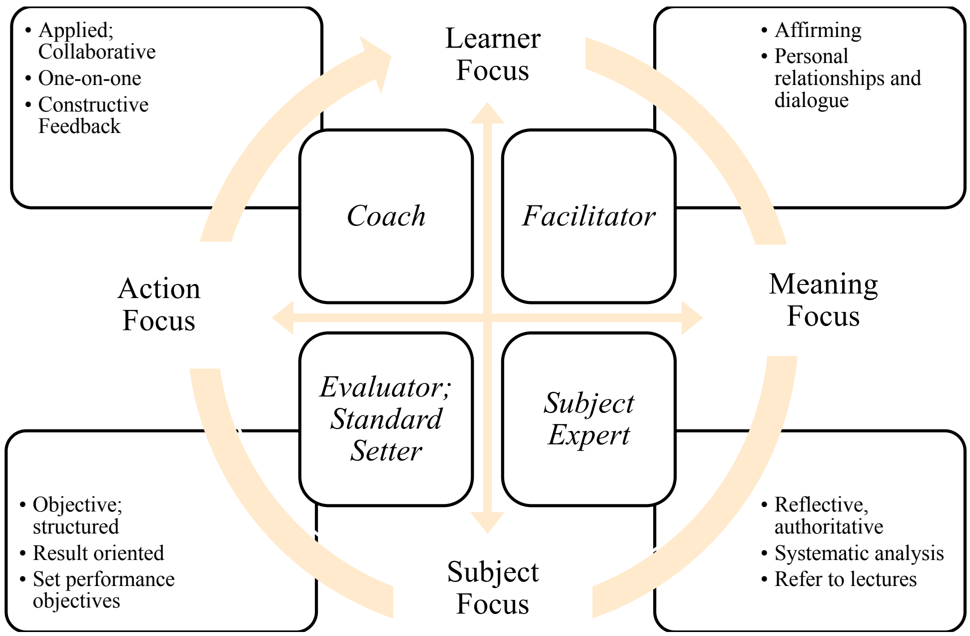

Figure 4.2. Educator Roles and the Learning Cycle [Based on Kolb and Kolb (2013)]

Figure 4.2 describes the educator role profile (ERP). The roles help learners maximize learning, accompanying them through the change of quadrants in the cycle:

- The facilitator role: educators provide an environment where learners can associate a theme to their personal experience and reflect on it. The affirming characteristic of the role allows personal relationships with the learners, often by facilitating conversation in small groups.
- The expert role: educators help organize the learners' reflection to the subject in question. In an authoritative style, educators teach by example, modeling critical thinking. Often achieved through lectures and readings.
- The evaluator role: the focus of this role is for the learner to meet performance requirements. An objective, result-oriented style is necessary for measuring

performance and quality, and to assess whether the learner has achieved knowledge and skill standards.

- The coaching role: educators plan on helping the learners apply acquired knowledge in order to achieve goals. The collaborative style is often better practiced one-on-one. An important part of this role definition is providing feedback on performance.

Since experiential learning, specifically internships, belong mainly to the fourth quadrants, as established in the second chapter, a coaching role corresponds better and is more expected from the educator involved. This explains the challenges perceived in terms of evaluation, being out of the scope of the required role. The coaching role, as described by Kolb (2013) involves feedback; however, this type of feedback is characterized by direct communication and constructive comments – as opposed to an evaluation consisting of a list of questions and a scoring system. Thus, there is a need for guiding evaluators in the coaching role, or better yet simplifying the process in a way to rely simply on observations corresponding to scores, in lieu of arbitrary judgment, with respect to the expertise playing a major role in the judgment.

4.5.2. Intra-Class Coefficient (ICC)

In order to better visualize the need for a scoring definition in the survey used for data collection in the study, grades provided by the industry evaluators seem to lack in alignment when measuring the same observations, i.e. student performance. The inter-rater reliability can be used to appraise the agreement in categorical scales. For quantitative studies, an Intra-Class Correlation (ICC) can be computed (Fleiss and Cohen, 1973). ICC examines the agreement between evaluators in the same position level on the *suggested grade* when scoring student performance.

In this study, students in the test will be grouped based on similar journal grades, to be considered on an equal academic level. Evaluators are grouped under position level, as defined in their scope of work by the Department of Labor jobs description (2019). Portney and Watkins (2009) define an ICC lower than 0.70 to be poor. The ICC coefficient found in this study is close to 0.2 which indicates a very low agreement between graders in the industry when scoring the same observation (student performance). The results show that there is a need for standardizing the scoring definitions, making the scores that are originally from 0 to 6 less arbitrary and based on observations.

4.5.3. Learning Inventories

The Kolb Learning style inventory is an example of an existing assessment of students to understand their preferred type, thus the role of the direct evaluator. Results of the inventory also indicate the level of student knowledge in certain areas. This means that the results can also be used by the academic unit before the internship semester, to identify weaknesses and assess the readiness of an individual before applying for an internship.

There is a need for a standardized definition of each survey question listed earlier. Limitations in ways to measure soft skills have been the challenge of many previous studies. The following definitions rely simply on transforming the survey into a short and pleasant experience for the grader, since time spent on the evaluation is one of the pressures felt by evaluators. The scoring definitions also provide clarity from numbers, to better align evaluators and learners around a given score. Table 4.4 presents question scores that correspond to specific intern behavior, based on the definitions provided for each question. The definitions as presented in Table 4.4 are proposed as an addition to the internship packet that students present to their host company as they start their internship. Evaluators can then refer to the definitions as a standardized rubric while scoring student performance in each of the 15 questions.

Table 4.4. Scoring Definitions and Rubric for the 15 Survey Questions

Question 1	**Punctuality and attendance**						
Description	Intern arrives to work on time, every day.						
Score	N.A.	1	2	3	4	5	6
Definition	-	Consistently arrives late and absent during work hours.	Arrives late and/or is not present during work hours more than 50% of the time	Arrives late most of the time, even if present every day	Arrives late and/or is not present during work hours, more than one time	Arrives late and/or is not present during work hours, one time	Consistently present during work hours and arrives on time
Question 2	**Dependability**						
Description	Intern is able to carry out instructions and assignments effectively and meet commitments						
Score	N.A.	1	2	3	4	5	6
Definition	-	Consistently asks for instruction clarification, and does not meet commitments	Consistently asks for direction, does *not always* meet commitments	Does not meet commitments more than 50% of the time	Does not meet commitment one time	Asks for instruction clarification but *always* meets commitments	Consistently carries out instructions accurately, and always meets commitments
Question 3	**Time management**						
Description	Intern is able to efficiently schedule tasks so assignments are completed on time						
Score	N.A.	1	2	3	4	5	6
Definition	-	Consistently completes assignment late	Does not complete more than 75% of assignments on time	Does not complete 50% of the assignments on time	Does not complete 25% of the assignments on time	Does not complete one assignment on time	Consistently completes assignments on time

Question 4	**Attitude, enthusiasm**						
Description	Intern consistently displays a positive outlook						
Score	N.A.	1	2	3	4	5	6
Definition	-	Consistently displays a negative outlook and no interest	Shows negative outlook, does not show enjoyment	Shows negative outlook when opposed	Does not display enthusiasm when assigned new work	Does not display positive outlook one time	Consistently displays positive outlook and enthusiasm
Question 5	**Productivity**						
Description	Effectively uses time and energy to complete tasks						
Score	N.A.	1	2	3	4	5	6
Definition	-	Ineffective use of time and energy is consistently the reason of incomplete tasks	Does not complete most of tasks due to ineffective use of energy	Does not complete 50% of tasks due to ineffective use of energy	Does not complete 25% of tasks due ineffective use of energy	Does not complete one task due to weak time and energy management	Consistently uses time and energy in an effective manner to complete tasks
Question 6	**Quality of work performed**						
Description	Intern is able to ensure project quality by producing consistent error-free work						
Score	N.A.	1	2	3	4	5	6
Definition	-	Consistently produces work with errors	Consistently produces work with human error	Produces 25% of the work with error	Produces 50% of the work error-free	Produces 75% of the work error-free	Consistently produces error-free work

Question 7	**Judgment**						
Description	Intern is able to make decisions based on logical assumptions that result in reasonable conclusions						
Score	N.A.	1	2	3	4	5	6
Definition	-	Never makes reasonable conclusions	Does not rely on reasonable assumptions even when resulting conclusions are reasonable	Relies on logical assumptions but does not propose reasonable conclusions	Relies on logical assumptions but makes reasonable conclusions only 50% of the time	Relies on logical assumptions but makes reasonable conclusions only 75% of the time	Consistently relies on logical assumptions and presents sound conclusions
Question 8	**Integrity, creativity**						
Description	Intern is able to generate creative solutions and develop better ways to perform tasks						
Score	N.A.	1	2	3	4	5	6
Definition	-	Never generates creative solutions	Does not attempt to generate creative solutions even when asked	Attempts to generate creative solutions when asked	Generates creative solutions and attempts to develop better ways to perform tasks	Generates creative solutions most of the time	Consistently generates creative solutions and develop better ways to perform tasks
Question 9	**Adaptability and versatility**						
Description	Intern is able to adapt behaviors and methods to ensure project success						
Score	N.A.	1	2	3	4	5	6
Definition	-	Behavior and methods are consistently limited	Limited flexibility in behavior and methods even when advised	Behavior and methods threatened project success more than once	Was not able to adapt behavior and methods more than once	Was not able to adapt behavior and methods once	Consistently adapts behaviors and methods

Question 10	**Oral communication skills**						
Description	Intern is able to make decisions based on logical assumptions that result in reasonable conclusions						
Score	N.A.	1	2	3	4	5	6
Definition	-	Never conveys a verbal message clearly	Weak oral communication threatens performance	Listener does not understand the verbal message after several attempts	Listener does not understand the verbal message from the first time	Conveys a verbal message clearly most of the time	Consistently conveys a verbal message clearly
Question 11	**Writing skills**						
Description	Intern is able to generate creative solutions and develop better ways to perform tasks						
Score	N.A.	1	2	3	4	5	6
Definition	-	Never communicates ideas clearly and concisely; inappropriate structure and grammar	Weak writing skills threatens performance	Communicates ideas with difficulty	Communicates clear ideas; needs improvement in organization, structure, and grammar	Communicates clear ideas, with proper organization and structure; but wrong grammar usage	Consistently communicates clear ideas with proper organization, structure, and grammar
Question 12	**Initiative**						
Description	Intern is able to adapt behaviors and methods to ensure project success						
Score	N.A.	1	2	3	4	5	6
Definition	-	Never demonstrates self-starter behavior, and does not show ambition	Waits for instructions after completing every task	Takes initiative when necessary, but waits for direction to move forward	Takes initiative when necessary, needs and asks for direction	Takes initiative most of the time but needs direction	Consistently demonstrates self-starter characteristics and needs little direction

Question 13	**Humbleness**						
Description	Student conduct was generally thought to be unpretentious, modest, and without arrogance						
Score	N.A.	1	2	3	4	5	6
Definition	-	Conduct is always pretentious and arrogant	Conduct is pretentious and arrogant when opinions and methods are opposed	Student does not accept comments from the first time they are given	Conduct is arrogant when opinions and methods are opposed, but student accepts comments	Conduct is generally unpretentious, even when opposed	Conduct is always thought to be unpretentious, modest, and without arrogance
Question 14	**Safety**						
Description	Student implemented OSHA safety standards appropriately in the work environment in which they performed tasks						
Score	N.A.	1	2	3	4	5	6
Definition	-	Never implements OSHA safety standards appropriately in the work environment	Does not implement OSHA standards appropriately even when advised	Does not implement OSHA standards appropriately more than 50% of the time	Does not implement OSHA standards appropriately more than once	Does not implement OSHA standards appropriately once in the work environment	Consistently implements OSHA safety standards appropriately in the work environment
Question 15	**Overall performed**						
Description	Overall performance during the internship						
Score	N.A.	1	2	3	4	5	6
Definition	-	Unsatisfactory performance	Weak performance with basic assignments	Weak performance when tasks are unfamiliar	Good performance even when tasks are unfamiliar	Fails to accomplish one task over the period of the internship	Consistently accomplishes assignments during the full internship

The definitions use the word "consistently", or similar meaning, for both extremes. With the scoring definitions, a positive extreme (repeating high score of 6 on all questions) would indicate that the intern has never done any mistakes in terms of the SLOs considered in the survey, which raises the question of the evaluator's credibility. This is meant to tackle the first threat mentioned in the previous section, in order to further reduce the standard error of the estimate in the proposed model.

4.5.4. Updated Survey

Construction education has to adapt and continuously evolve to be aligned with the industry needs. Consequently, the 15 questions survey is updated in 2018 to touch on more SLOs. The updated survey includes questions related to ethics, legal implications, management concepts, in addition to more technical learning objectives that are directly related to day-to-day activities on the job. The original 15 questions are mostly preserved, in addition to 12 new questions, presented in Table 4.5.

The newly added questions are measurable observations directly related to tasks performed during internships, which do not present the psychometrics challenges – science of measuring mental capacities and soft skills competences – faced in social studies and soft skills. They can be graded by the educator – playing the role of *coach*, as described by Kolb in previous sections – since the direct evaluator is now an *expert* in the task as well as a *standard setter* – also described based on Kolb's definitions in the previous sections. This ultimately increases the ICC coefficient potentially indicating more agreement between different evaluators.

Table 4.5. Questions Added to the Updated Survey

No.	Question	Description
1	Electronic-based skills	Intern was able to apply electronic-based technology to manage the construction process
2	Ethics	Intern was able to evaluate and make professional decisions based on ethical principles
3	Construction documents	Intern was able to analyze the construction documents for planning and management of the construction process
4	Cost estimate	Intern was able to create construction project estimates appropriate to their assigned duties
5	Cost control and accounting	Intern understood principles of cost control and accounting as it pertained to assigned duties
6	Surveying	Intern was capable of applying basic surveying techniques for construction layout and control
7	Project delivery method	Intern has a clear understanding of different delivery methods and the constituents involved in design and construction
8	Legal	Intern understood the legal implications of contract, common and regulatory law used to manage the construction project
9	Structural behavior	Intern understood the basic principles of structural behavior as it pertained to assigned duties
10	Electrical systems	Intern understood basic principles of mechanical systems as it pertained to assigned duties
11	Mechanical and piping systems	Intern understood basic principles of mechanical systems as it pertained to assigned duties
12	Technical capability	Student had basic knowledge of methods, materials, and told to carry out assigned tasks

Moreover, some descriptions of the questions from the original survey have been modified to better convey the abilities expected from the student by the construction industry, and *overall performance* was removed from the updated survey, to avoid confusion with *suggested grade*. The modified descriptions are as follows

- Question 11: *Written communication skills*. Intern is able to write clearly their ideas with proper organization and grammar *for the construction discipline*.

- Question 14: *Safety*. Student created a project safety plan appropriate to the work environment in which they performed tasks.

Cohen (1983) explains in a study on statistical tests that more factors in the model can contribute to its accuracy and reliability, given that the assumptions are tested and there is statistical significance. Having 26 questions as a basis for generating the model, in addition to accurate observational descriptions for each of the questions allow the dataset to have more explanatory variables (independent variables) related by definition to the suggested grade by the construction industry, and more accurate scores. Both improvements benefit the original aim of this study to better understand the industry valued skills and students' level in each of them.

4.6. DISCUSSION

4.6.1. Skill Measurement

After conducting an exploratory analysis on the survey responses, several discussion points emerged concerning the nature of the sectors in the construction industry and the different values they hold. There was statistically significant variance between the grading in two different sectors, but that could also mean that the survey is possibly not gathering all the relevant data. In other words, the evaluation form might not be a "one size fit all". Atkins (1999) suggests that employers do not necessarily have a common set of skills that are expected of graduates, and concludes his study with stating that skillset requirements vary with region, size of business, market, etc. It would be interesting to look at the differences between vertical and horizontal markets for instance, and investigating the relevant questions or better yet the valued skills of each of them.

Another variable that plays a role in the direct evaluator's approach to the evaluation form is their position level (executive, management, site work, etc.). Employees in a company can share its culture and values, and that helps in terms of questions related to behavior and ethics; however, for some questions addressing technical capabilities, evaluators in different positions have different opinions. Some interns are graded by several employees on different position levels, due to their rotation during their internship. The established way to manage several evaluation forms is to compute the average for each question. That raises the question of weighted averages, where an evaluator's grade has more weight due to the amount of time spent with the intern or to the relevance of the skill measured to each evaluator position. This means that differences in valued skills are not only possibly present between sectors, but also between evaluators in the same sector and company. There is a need for contextualized responses, creating subsets – based on sectors or evaluators position, etc. – with a detailed granular evaluation to achieve better accuracy in the data collection process. One interesting example would be specialty contractors as opposed to consultants. The analysis can investigate whether the two areas are measuring the same skills, or better yet, if all the skills in the evaluation form are relevant to both.

4.6.2. An Opposing and Dynamic Learning Environment

The construction program in Del E Webb School of Construction, ASU, covers prerequisites for internships such as an OSHA 30-hour card, plan reading, materials means and methods, heavy civil equipment, and being in a good standing. Technology is fast growing and the curriculum did not keep pace. BIM and scheduling for example, are areas where the available technologies are needed at entry level roles. This means that upper division skillsets should now be taught in the first two years of education. The curriculum introduces students to theories and concepts, without preparing them to the discomfort found on the job such as preparing an RFI or any other document, eliminating the responsibility of handling opposing ideas and/or negative professional feedback.

The goal is not to replace the curriculum, since this study has proven the importance of educational institutions as complementary to experiential learning ("pendulum style" explained in chapter 2). Academic institutions should aim for providing an opposing dynamic environment, accompanied with a feedback wheel. Adding an opposition component in the class can be done by inviting industry people to evaluate students in certain tasks, with realistic professional feedback instead of grades, to improve their mental preparedness and habit formation in terms of employment related capabilities and industry valued skills. Internships provide the dynamic and opposing environment discussed in this paragraph, in a professional setting. What is proposed here is the dynamic and opposing environment, in the academic setting, as a bridge between class and internship, potentially improving internship performance which will result in better experiential learning and ultimately better professionals.

4.7. CONCLUSIONS

The correlation between an interns' final grade on the internship course and their performance during the internship is close to zero. This is due to the fact that different evaluators are measuring different observations: the academic unit is assessing knowledge following a specific rubric, while an evaluator in the host company is giving a score based on student behavior – which is difficult to measure scientifically. This chapter aimed to explore the statistical relationship between the questions scored by the industry, in order to examine the statistical agreement in the scoring within the industry. This chapter explored the threats to validity identified in the dataset by computing a model with the highest predictors of student performance during the internship. Threats included consistent perfect scores received by 16.3% of the students, where 91% (14.9% of the total) are received from the commercial sector. A stepwise regression excluded these cases to examine their impact on the model. The highest predictors of student performance in the industry in the new dataset are:

1) Dependability: carries out instructions effectively and meets commitments
2) Productivity: effectively uses time and energy to complete tasks
3) Initiative: demonstrates self-starter who needs little direction
4) Ingenuity: generates creative solutions and develop better ways to perform tasks
5) Writing skills: communicates ideas with proper organization, structure, and grammar
6) Attitude: consistently displays a positive outlook towards work

The explanatory factors are listed by correlation coefficient with the industry suggested grade, ranging between 0.584 fand 0.393. The model, however, showed a standard error of the estimate equal to 0.21, showing an improvement from the previous model (standard error of estimate equal to 0.33) but still not reliable enough. Moreover, the inter class coefficient (ICC) assessing the agreement between industry evaluators scoring the same observation showed poor results, with a coefficient of 0.2. This indicates a low agreement between evaluators. To address these issues, a standardized scoring system is needed to align direct evaluators on an objective observation-based scoring. This study proposes a scoring definition and rubric to be added to the internship packet submitted to the industry during the internship: each question in the survey is now clearly described and followed by a choice of 7 grades, all of which are defined by palpable student behavior. Also, 12 more questions are added to cover more SLOs which were identified as needed skills by the industry, and previous questions were reformulated to relate more specifically to the construction industry (language and content). The survey now includes a total of 26 questions, which potentially allows the model to be more reliable.

CHAPTER 5

CONCLUSION

Research conclusions, contributions, and limitations are described, with a discussion on recommendations for future research efforts. The study contributes a new approach to look at internships by focusing on the benefits that the internship environment presents to construction students. Values from evaluations completed by industry professionals, assessing student performance during an internship, were analyzed to identify the industry valued skills. A predictive model, based on the identified highest predictors of student success in the construction industry, was generated and the study interprets its reliability. The modeling of student performance led to the detection of threats to validity, as part of the limitations of the study. Threats are then addressed and a new model with a different set of highest predictors is generated. Evaluations completed by the industry professionals presented a lack of statistical alignment in terms of scoring student performance. An updated survey is proposed as part of a new internship packet, allowing the academic unit to collect more accurate data based on scoring definitions and rubric for each question score, in addition to supplementary questions to increase the number of explanatory variables in the model. The accuracy of future responses and the higher number of predictors in the model are two main contributions to the experiential learning assessment process.

5.1. SUMMARY OF THE RESEARCH

The study has five objectives:

1. Recognize the most beneficial learning environment for construction students (literature review in chapter 2)

2. Identify the impact of predispositions and human variables on construction student performance in the industry (chapter 2)
3. Identify the highest predictors of construction intern's success (chapter 3)
4. Model student performance to predict the industry suggested grade based on the score received on specific areas during the internship (chapter 3)
5. Address threats to validity of the generated model, by contributing to the existing internship evaluation process (chapter 4)

5.2.SUMMARY OF THE FINDINGS

Learners can have different preferred learning styles which translates into different needs from the educator. The educator then takes different roles to support the learning style and eventually leads the learner into completing a learning cycle, as described by Kolb (1984). Educators in the internships are professionals in the construction industry, who are expecting a certain skillset from the student intern. Students are not sufficiently prepared due to the rapid evolution of the industry in comparison to the traditional curriculum. The analysis of the literature in chapter 2 emphasized the importance of the learning environment in addition to identifying learners' preferred style, to maximize the learning experience. The intern is in the center of the academic institution – host company partnership. Dee Fink's explains that the significant learning concept can be achieved in that central position.

Leadership education in construction is necessary to underline the necessity of developing soft skills. A statistical analysis was conducted to evaluate the effect size of predisposition and human variables such as ethnic groups, gender, age, marital status, military status, and sector choice, on the performance of students in the industry.

5.2.1. Literature and Human Variables Analysis

The literature analysis suggests that experiential learning is essential for construction education, and internships in particular present the proper environment that allows the learner to be in the center of the process, maximizing the learning experience. The results of the analysis computed on human variables and predisposition to examine their impact on student performance in the industry showed that there is no statistical significance between subgroups and industry suggested grade.

5.2.2. Highest Predictors of Construction Intern Success

Industry valued skills were identified by conducting an exploratory analysis on the student demographics in the construction industry. Data was collected form surveys completed by the industry as part of the student internship evaluation. Questions in the survey are aligned with the ACCE SLOs (as defined until 2007). By analyzing survey responses evaluating student performance in specific areas and testing for correlations with the suggested industry grade, the study showed that the highest predictors of student success in the industry are the following:

1) ingenuity and creativity

2) punctuality and attendance

3) initiative.

A prognostic model was created to predict the dependent variable based on the specific survey questions responses; however, fitting the suggested grade data (dependent variable) into a multivariate linear regression model did not provide reliable results.

Adding independent variables as potential significant explanatory factors may improve the fit of the model. In order to test student performance correctly, like any proper testing environment, elements influencing the experience have to be controlled.

5.2.3. Identifying and Addressing Threats to Validity

Providing specific guidance to evaluators can help control the testing environment, eventually allowing more accurate results. This study approaches that idea by excluding eminent threats from the model design first. The exploratory analysis results showed that a trend of consistent perfect scores exist predominantly in one sector of the industry – commercial sector – with 31.2% of the students receiving the total possible points. After excluding the high scores, the new list of highest predictors is the following, with *Initiative* remaining in the top 3:

1) Dependability: carries out instructions effectively and meets commitments
2) Productivity: effectively uses time and energy to complete tasks
3) Initiative: demonstrates self-starter who needs little direction
4) Ingenuity: generates creative solutions and develop better ways to perform tasks
5) Writing skills: communicates ideas with proper organization, structure, and grammar
6) Attitude: consistently displays a positive outlook towards work

The model generated using the new list of predictors showed an improvement when compared to the previous model but the standard error of estimate indicates that it is still not reliable enough.

Direct evaluators alignment is necessary to ensure that the collected responses are accurately measuring the SLOs (independent variables). Verifying whether the direct evaluators from the industry show agreement on the scoring system was achieved by conducting an intra-class correlation analysis (ICC). The ICC showed poor results, as expected, which indicates a low agreement between evaluators. This is likely a major reason for the low reliability of the predictive model. A standardized scoring system was created to align direct evaluators on an objective observation-based scoring. The proposed evaluation form includes scoring definitions and rubric to be added to the internship packet – document submitted to the industry during the internship which includes agreements with the academic institution. The agreements in the packet can propose to the evaluator to follow the new directions when completing the evaluation form. As described in chapter 4, each question in the survey is now clearly described and followed by a choice of 7 grades, all of which are defined by palpable student behavior. Also, 12 more questions are added to cover more SLOs which were identified as needed skills by the industry, and previous questions were reformulated using construction industry language and content. The survey now includes a total of 26 questions, which potentially allows the model to be more reliable.

5.2.4. Limitations of the Research

The lack of scientific background on psychometrics related to the skillset considered in this dissertation generates the main limitations in this study. The research uses definitions in accordance with SLOs which translate the industry needs and expectations from construction students entering the market. More detailed and dedicated measurements could be developed in the social studies in order to better examine student behavior and capacities during an experiential learning process. This could lead to more accurate survey results, thus a more reliable predictive model. A reliable model helps the academic unit with the support of the industry to identify weaknesses and opportunities for improvement in each student. This process based on feedback from the industry and development from the academic institution completes the cycle discussed in chapter 2, with the student covering all 4 stages early on in the education.

Another limitation is the generalizability of the results, relating to demographics of the students. Even though the sample size is acceptable and a power analysis confirmed this statement, the study may be representative of the local population, schools in the same region as Del E. Webb School of Construction, at ASU.

Lastly, limitations related to the mandatory nature of the internship are presented. It is true that this study supports internships as part of the indispensable partnership described in chapter 2; however, it would be interesting to compare the results with a school where internships are not mandatory. Results may suggest an impact on the overall performance, indicating a sense of responsibility and accountability in the student behavior which can also be included in the model as a explanatory factor.

5.3.DISUSSION

This study identified opportunities for future research efforts to examine the psychometrics of construction students during their internships – the science of measuring mental capacities and processes – in order to further improve the evaluation by providing a scientific way for inspecting behavior and soft skills in the industry. The discussion also included the opposing nature of the internship environment, and the study suggests for the academic unit to provide a similar environment in the academic setting to better prepare student for their internships.

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APPENDIX A

15 SURVEY QUESTIONS

Student Observations (Continued)

Del E. Webb School of Construction

CON 484 Management Internship Evaluation Form – Spring 2014 Session B or C

Student Name

Student Name: ____
Last *First*

Internship Evaluator: Point of Contact

Company Name: ____

Evaluator Name: ____
Last *First*

Title: ____

Phone: ____________________ Email: ____________________

Evaluator Guidelines

- This evaluation is to be completed for the student intern at the end of the 320 hr requirement
- We encourage the employer to review the evaluation with the student intern.
- If any performance is below average, please elaborate (attach page if necessary).
- If a formal evaluation is utilized by the company, please submit a copy with this form.

Student Observations

Scale: 1 = Unacceptable | 2 = Below Average | 3 = Barely Acceptable | 4 = Average | 5 = Above Average | 6 = Superior | N/A = Not Applicable

Scaling also includes half points marked with the "•" symbol.

		Please circle the appropriate rating:
1.	**Punctuality and Attendance:** Intern arrives to work on time, every day.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
2.	**Dependability:** Intern is able to carry out instructions and assignments effectively and meet commitments.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
3.	**Time management:** Intern is able to efficiently schedule tasks so assignments are completed on time.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
4.	**Attitude, enthusiasm:** Intern consistently displays a positive outlook towards work.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
5.	**Productivity:** Effectively uses time and energy to complete tasks.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
6.	**Quality of work performed:** Intern is able to ensure project quality by producing consistent error-free work.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
7.	**Judgment:** Intern is able to make decisions based on logical assumptions that result in reasonable conclusions.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A

Page **1** of **2**

Student Observations (Continued)

Del E. Webb School of Construction

CON 484 Management Internship Evaluation Form – Spring 2014 Session B or C

Student Name

Student Name: ____
Last *First*

Internship Evaluator: Point of Contact

Company Name: ____

Evaluator Name: ____
Last *First*

Title: ____

Phone: ____________________________ Email: ________________________________

Evaluator Guidelines

- This evaluation is to be completed for the student intern at the end of the 320 hr requirement
- We encourage the employer to review the evaluation with the student intern.
- If any performance is below average, please elaborate (attach page if necessary).
- If a formal evaluation is utilized by the company, please submit a copy with this form.

Student Observations

Scale: 1 = Unacceptable | 2 = Below Average | 3 = Barely Acceptable | 4 = Average | 5 = Above Average | 6 = Superior | N/A = Not Applicable

Scaling also includes half points marked with the "•" symbol.

		Please circle the appropriate rating:
1.	**Punctuality and Attendance:** Intern arrives to work on time, every day.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
2.	**Dependability:** Intern is able to carry out instructions and assignments effectively and meet commitments.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
3.	**Time management:** Intern is able to efficiently schedule tasks so assignments are completed on time.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
4.	**Attitude, enthusiasm:** Intern consistently displays a positive outlook towards work.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
5.	**Productivity:** Effectively uses time and energy to complete tasks.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
6.	**Quality of work performed:** Intern is able to ensure project quality by producing consistent error-free work.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A
7.	**Judgment:** Intern is able to make decisions based on logical assumptions that result in reasonable conclusions.	1-•- 2 -•- 3 -•- 4 -•- 5 -•- 6 N/A

Page **1** of **2**

APPENDIX B

26 SURVEY QUESTIONS

Del E. Webb School of Construction
CON 484 Internship Evaluation Form – Fall 2019

Student Intern Name
Student Name: ____   *Last* *First*

Internship Evaluator: Point of Contact
Company Name: ____
Evaluator Name: ____   *Last* *First*
Title: ____
Phone: ____________________________ Email: ________________________________

Evaluator Guidelines
• This evaluation is to be completed for the student intern at the end of the 320 hour requirement   • We encourage the employer to review the evaluation with the student intern.   • If a formal evaluation is utilized by the company, please submit a copy with this form.

Student Observations

Scale: 1 = Unsatisfactory | 2 = Satisfactory | 3 = Above Expectation | 4 = Outstanding | N/A = Not Applicable
Scaling also includes half points marked with the "•" symbol.

		Please circle the appropriate rating:
1.	**Punctuality and Attendance:** Intern arrives to work on time, every day.	1-•- 2 -•- 3 -•- 4 N/A
2.	**Dependability:** Intern is able to carry out instructions and assignments effectively and meet commitments.	1-•- 2 -•- 3 -•- 4 N/A
3.	**Time management:** Intern is able to efficiently schedule tasks so assignments are completed on time.	1-•- 2 -•- 3 -•- 4 N/A
4.	**Attitude, enthusiasm:** Intern consistently displays a positive outlook towards work.	1-•- 2 -•- 3 -•- 4 N/A
5.	**Productivity:** Effectively uses time and energy to complete tasks.	1-•- 2 -•- 3 -•- 4 N/A
6.	**Quality of work performed:** Intern is able to ensure project quality by producing consistent error-free work.	1-•- 2 -•- 3 -•- 4 N/A
7.	**Judgment:** Intern is able to make decisions based on logical assumptions that result in reasonable conclusions.	1-•- 2 -•- 3 -•- 4 N/A
8.	**Ingenuity, creativity:** Intern is able to generate creative solutions and develop better ways to perform tasks.	1-•- 2 -•- 3 -•- 4 N/A

Scale: 1 = Unsatisfactory | 2 = Satisfactory | 3 = Above Expectation | 4 = Outstanding | N/A = Not Applicable
Scaling also includes half points marked with the "•" symbol.

		Please circle the appropriate rating:
9.	**Adaptability and versatility:** Intern was able to adapt behaviors and methods to ensure project success.	1-•- 2 -•- 3 -•- 4 N/A
10.	**Oral communication skills:** Intern was able to speak clearly their ideas within the professional work environment.	1-•- 2 -•- 3 -•- 4 N/A
11.	**Written communication:** Intern was able to write clearly their ideas with proper organization and grammar for the construction discipline.	1-•- 2 -•- 3 -•- 4 N/A
12.	**Electronic-based skills:** Intern was able to apply electronic-based technology to manage the construction process.	1-•- 2 -•- 3 -•- 4 N/A
13.	**Initiative:** A demonstrated self-starter who needs minimal direction.	1-•- 2 -•- 3 -•- 4 N/A
14.	**Ethics:** Intern was able to evaluate and make professional decisions based on ethical principles.	1-•- 2 -•- 3 -•- 4 N/A
15.	**Humbleness:** Student's conduct was generally thought to be unpretentious, modest and without arrogance.	1-•- 2 -•- 3 -•- 4 N/A
16.	**Safety:** Student created a project safety plan appropriate to the work environment in which they performed tasks.	1-•- 2 -•- 3 -•- 4 N/A
17.	**Construction Documents:** Intern was able to analyze construction documents for planning and management of the construction process.	1-•- 2 -•- 3 -•- 4 N/A
18.	**Cost Estimates:** Intern was able to create construction project estimates appropriate to their assigned duties.	1-•- 2 -•- 3 -•- 4 N/A
19.	**Cost Control & Accounting:** Intern understood principles of cost control and accounting as it pertained to assigned duties	1-•- 2 -•- 3 -•- 4 N/A
20.	**Surveying:** Intern was capable of applying basic surveying techniques for construction layout and control.	1-•- 2 -•- 3 -•- 4 N/A
21.	**Project Delivery Methods:** Intern has a clear understanding of different project delivery methods and the constituents involved in design and construction.	1-•- 2 -•- 3 -•- 4 N/A
22.	**Legal:** Intern understood the legal implications of contract, common and regulatory law used to manage the construction project(s).	1-•- 2 -•- 3 -•- 4 N/A
23.	**Structural Behavior:** Intern understood the basic principles of structural behavior as it pertained to assigned duties.	1-•- 2 -•- 3 -•- 4 N/A
24.	**Electrical Systems:** Intern understood basic principles of electrical systems as it pertained to assigned duties.	1-•- 2 -•- 3 -•- 4 N/A
25.	**Mechanical and Piping Systems:** Intern understood basic principles of mechanical systems as it pertained to assigned duties.	1-•- 2 -•- 3 -•- 4 N/A
26.	**Technical Capability:** Student had basic knowledge of methods, materials and tools to carry out assigned tasks.	1-•- 2 -•- 3 -•- 4 N/A

Please identify three (3) areas in which the student intern is most improved.

1. ____

   ____

2. ____

   ____

3. ____

   ____

Please identify three (3) areas in which the student in greatest need of skill development.

1. ____

   ____

2. ____

   ____

3. ____

   ____

Internship Supervisor Recommended Grade for Student Intern

What grade would you give your student intern?

(Please circle appropriate Grade)

A+ A A- B+ B B- C+ C C- D E

Grading Scale

A = Superior Work | B = Excellent Work | C = Average Work | D = Below Average Work | E = Unacceptable

Internship Evaluator Signature_______________________________________ Date ________________

Has the student intern reviewed the internship evaluation? __ Yes __No

Please return this form to Matthew Eicher
Fax: (480) 965-0557 **Or E-mail:** eicher@asu.edu

APPENDIX C

IRB APPROVAL

EXEMPTION GRANTED

Anthony Lamanna
SEBE: Sustainable Engineering and the Built Environment, School of
480/727-0155
DrTony@asu.edu

Dear Anthony Lamanna:

On 8/6/2019 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Exploratory Analysis of Student Performance in the Construction Industry.
Investigator:	Anthony Lamanna
IRB ID:	STUDY00010440
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• CON 484 Internship Evaluation Form, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Protocol, Category: IRB Protocol; • CON 296 Internship Evaluation Form, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (1) Educational settings, (2) Tests, surveys, interviews, or observation on 8/6/2019.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

APPENDIX D

LIST OR EVALUATORS TITLES

List of evaluators titles (1/3)

Position	Count
Project Manager	249
Superintendent	94
Project Engineer	57
Construction Manager	39
Estimator	33
Chief Estimator	27
Senior Estimator	27
President	25
Vice President	22
Assistant Project Manager	20
Operation Manager	17
Foreman	16
Owner	12
CEO	11
Field Engineer	11
Supervisor	11
Project Director	8
Office Manager	7
Division Manager	6
Engineer	6
Quality Control Manager	6
Preconstruction Manager	5
Program Manager	5
Assistant Superintendent	4
CFO	4
Company Owner	4
Construction Area Manager	4
Director of Construction	4
Director of Virtual Construction	4
Estimating Manager	4
Facility Manager	4
Laboratory Supervisor	4
Manager	4
Member	4
Operations Director	4
Technical Service Representative	4
Vice President of Construction	4
Area Manager	3
Director	3
Partner	3
Principal	3
Project Control Manager	3
Project Executive	3

List of evaluators titles (2/3)

Position	Count
Vice President Commercial & Residential	3
Administrative Assistant	2
APDM Manager	2
Applied Technologies Team Manager	2
Apprentice Supervisor	2
Assistant Professor	2
BIM Manager	2
Business Development Manager	2
Chief Field Engineer	2
Chief Technical Officer	2
CMT Department Manager	2
Concrete Area Manager	2
Construction Engineer	2
Construction Service Manager	2
Construction Technology Manager	2
Consultant	2
Controller	2
Corporate Trainer BIM	2
Design Phase Executive	2
Development Manager	2
Diector of Pipeline Rehab	2
Director of Estiating	2
Director of Field Operations	2
Director of Operations	2
Director of Pavement Maintenance	2
Director of Preconstruction	2
Director of Residential Construction	2
District Quality Manager	2
Field Director	2
General Manager	2
Head of Facilities & Utilities Maintenance	2
Head of Preconstruction	2
Industrial Engineering Manager	2
Laboratory Manager	2
Landscaoe Architect	2
Lead Project Engineer	2
Manager of Engineering	2
Manager of Facilities Engineering	2
Manager of Facility Development	2
Preconstruction Services	2
Project Business Manager	2
Property Manager	2
Realtor	2

List of evaluators titles (3/3)

Position	Count
Resident Engineer	2
Senior Superintendent	2
Site Representative	2
Special Operations	2
Supervisor Facilities	2
Supervisory Contract Specialist	2
Talent Coordinator	2
Vice President Aggregates & Asphat	2
Vice President of Operations	2
Vice President of Procurement	2
Vice President of Quality Assurance	2
Vice President of Sales & Marketing	2
Assistant Manager Manufacturing	1
Director of Job Order Contracting	1
Director of Sales & Marketing	1
Director of Technical Services	1
District Sales Manager	1
Executive Vice President	1
Facility Engineering Manager	1
Field Manager	1
Project Control Analyst	1
Purchasing Manager	1
Quality Control Supervisor	1
Recruiter	1
Safety Manager	1
Sales Manager	1
Senior Engineer	1
Testing & Inspection Manager	1
Vice President Development	1
Vice President of Estimating	1
Vice President of Subfabrication	1