Perceptions of Structures Coursework for Career Fulfillment from the Student and Practitioner Perspective

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Abstract
When students are not certain that a course is tied to their future career, students may place reduced value on the course content. For students in engineering and engineering technology, there are a variety of courses required for graduation. In addition to these major courses, for university degrees, a well-rounded education is required. This requirement results in general education requirements like humanities, mathematics, physics, and engineering sciences. In both major and non-major courses, student perception of value can affect their classroom participation, grades and rhetoric. This rhetoric can also be identified after graduation by industry professionals and faculty alike as they discuss the courses which are perceived to hold higher value. Lower value courses may be those which are taught by other faculty, courses required for accreditation or even those required by the university. This research focuses on student and practitioner perception of value of both major and non-major coursework. A survey instrument was created which compares structures or structural engineering courses to other required courses. The sample includes architecture, architectural engineering, construction management, construction engineering technology and construction engineering students and industry professionals. These individuals were chosen due to their structural coursework requirements and overlapping industry relationships. As all of these graduates will end up in the construction related industry, it is of interest how their perceptions vary.

Introduction

Students and faculty alike can question the validity of certain coursework to a degree program. As the ABET requirements change over time, programs respond to the change with curriculum changes [1} Additionally, as a student progresses into their career, their perception of self also changes. A student may see themselves as a mediator between science and math, a tinkerer or a social servant striving to better the world [2]. Student thoughts about their future career or "career thoughts" may also affect attitudes, behaviors, beliefs, feelings, plans, and/or strategies [3], [4].

Student perception of self may attribute to their attitude about coursework. Attitude is made up of 5 components including; emotion, goal, direction, strength and consistency [5]. Although a thorough review of the available literature was performed, there is little research published on the topic of student attitude versus performance in structures, mechanics or even other engineering courses. Some studies have been performed in other disciplines. Attitude has previously been tied to learning and course perception in Statistics courses [6], [7]. This attitude towards learning may also be associated with "perceived instrumentality" in learning. Perceived

Instrumentality is a concept that identifies why an individual might choose to or not to focus on a particular topic based on their perception that it may be needed at a later time [8].

Changes to the professions and the tools and technology which support them may also affect curriculum. Suggestions for change may come from industry or from the accrediting board [1], [9]. Anecdotally the authors have heard feedback from industry on hand calculations versus learning the software to do the same. Current graduates are between the Millennial Generation and Generation Z, which means that they could also be classified as the Net Generation or Digital Natives [10], [11]. Referring to comments from Industrial Advisory Board (IAB) members, there is an expectation that current graduates can quickly learn any new software. It is understanding the theory which the new generation needs to learn. Students self-report feeling quite confident about writing spreadsheets or performing computer maintenance [11]. However, students may not have fully embraced all social media [11], [12], [13].

A cross-sectional study has been performed focusing on two major groups affected by coursework. Collegiate students at two universities were surveyed. The students were enrolled in Architecture, Architectural Engineering, Construction Engineering Technology or Construction Management Science programs which require structural engineering courses. Alumni serving on an IAB were also surveyed. The alumni were graduates of the same majors as the students. All of the programs include a structures series of Statics, Concrete Design and Timbers Design.

Architecture has long observed that there was a difference between the traditional studio curriculum and the math-based engineering courses [9], [14]. Statics, concrete and timbers are all traditionally lecture based courses. They typically include a lab or recitation to augment the lecture with examples performed by teaching assistants or in-class group work. Lastly, there is an expectation for work completed outside of class. All of these courses have mid-term and final exams. Although all of these majors traditionally have a focus on construction methods and structural engineering, many students do not feel that the structures sequence applies to all students.

Background

Anecdotally, students and recent graduates report that they do not find all major courses relate to their perception of the needs of their future careers. This attitude may contribute to learning or in some cases cause a negative impact on learning [6], which is what prompted this research. A survey was created to capture the perceptions of both students and the IAB on the importance of major courses, especially those courses in the structural engineering module, although not exclusively for structural engineers. Structural engineering type coursework is found in Civil Engineering, Construction Management/Engineering and Architectural Engineering degrees. It is the depth of the coursework in this topic area which distinguishes the different degrees. Further it

is also related to the research question, do all students place the same value on coursework which they may not perceive to be important to their careers.

Another overarching research question is whether or not structures classes are supported by other faculty and industry. It is important to know if industry values these courses. In some cases, non-engineering faculty might disparage structures courses as being irrelevant. Faculty might also point to whether the courses are on required exams for licensure. Industry professionals who students encounter on internships or know outside of the university setting may also affect this perception. If student mentors from industry state that technical courses have more or less validity than the general education coursework, student perceptions may reflect the same. Other factors may include feedback from peers.

A survey instrument was developed to determine how students and industry members perceive their major courses and if their attitude correlates with their self-reported grades. A positive correlation would indicate that attitude is a factor in learning. Further by measuring industry perceptions, additional insight will be provided into whether these courses are used after graduation. There were no questions as to how the perceptions were formed, although this could be the focus of a future study.

Methodology

The study utilized a survey method to identify the importance of structural design coursework and compared with humanities, writing, calculus, English literature coursework required at a university in Oklahoma and a university in Indiana. The survey was to determine which courses respondents perceive to be important. Further the respondents were asked to self-report their grades in their college coursework. The survey had three sections: demographics, importance of specific courses and self-report grades. The survey consisted of questions that were multiple choice and text based. The survey questions were designed in such a manner that the respondents could complete the study within 10 minutes, provided they possessed all the answers.

The survey respondents were undergraduate students from both a university in Oklahoma and Indiana. Students respondent were two courses (CEMT 260 and CEMT 486) from a university in Indiana. The CEMT 260 course is traditional strength of materials. The CEMT 486 course is a reinforced concrete design. The university in Oklahoma included three respondent groups, IAB members and students from two different programs. The student respondents were from two classes (CET 3554 and ARCH 3223) from a university in Oklahoma. The CET 3554 course is focused on steel and concrete design, while the ARCH 3223 course is focused on timber design. The survey questions are listed below.

Survey

Demographic Questions: What is your major? _____

How do you self-identify? Male Female Other

What is your race? African-American American Indian or Alaska Native Asian
Caucasian Hispanic Native Hawaiian or Other Pacific Islander
Other or prefer not to state

Questions about the courses are as follows.

		Agree				Disagree
DC1	The majority of my major courses are relevant.	1	2	3	4	5
DC2	Humanities courses are relevant to my career after college.	1	2	3	4	5
DC3	Structural design courses are relevant to my career after college.	1	2	3	4	5
DC4	Writing courses are easy for me.	1	2	3	4	5
DC5	Major courses are relevant to my career.	1	2	3	4	5
DC6	Structural design courses are difficult to understand.	1	2	3	4	5
DC7	Critical thinking courses are important to my career.	1	2	3	4	5
DC8	Calculus courses are not applicable after graduation.	1	2	3	4	5
DC9	English Literature courses are meaningful to me.	1	2	3	4	5
DC10.	My degree is required for my career path.	1	2	3	4	5

Questions in reference to self-reporting grades are as follows.

Self-report your average grades for the following course types:

1. Major courses A B C D
2. Critical Thinking A B C D
3. Structures A B C D
4. English Literature A B C D
5. Calculus A B C D
6. Humanities A B C D
7. English Writing A B C D

Data Analysis

A total of 106 survey responses were collected and were made up of IAB members and students as shown in Figure 1. Students at two universities were surveyed. Those respondents were distributed over sophomore, junior and senior level courses. Students respondents were from two courses (CEMT 260 and CEMT 486) from a university in Indiana. The CEMT 260 course is strength of materials, which is a sophomore level class. Prerequisite of CEMT 260 is Statics. The CEMT 486 course is a reinforced concrete design. which is a senior level class. Prerequisite of CEMT 486 is Statics and CEMT 260. The student respondents were from two classes (CET 3554 and ARCH 3223) from a university in Oklahoma. The CET 3554 course is focused on steel and concrete design, and the ARCH 3223 course is focused on timber design. Both classes are junior level class and prerequisite is also strength of materials. The surveys were provided to the IAB during a regular meeting. Surveys were provided to students during class with no incentive

given. Both IAB members and students were allowed to leave or turn in blank copies of the survey. The survey was proctored by a third party, so there was no pressure to respond.

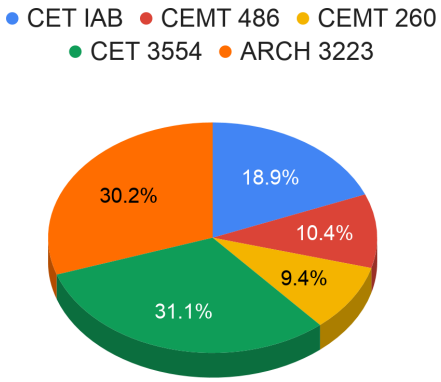

Figure 1 – Respondent Distribution by Survey Location

Figure 2 illustrates the majors of the respondents. The university in Indiana has respondents enrolled in Construction Management Technology or Civil Engineering degrees. The university in Oklahoma has students enrolled in a Construction Engineering Technology, Architecture or Architectural Engineering degrees.

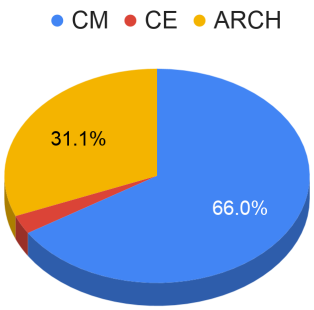

Figure 2 - Percent of Students by Major

In line with expectations for architecture, engineering and technology degrees [15], the majority of the female respondents are enrolled in Architecture. There were twenty-six female respondents, of which 20 are seeking Architecture degrees. Gender distribution is shown in Figure 3.

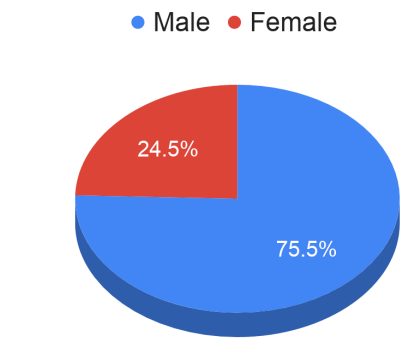

Figure 3 – Demographics Based on Gender

Similarly, the majority of the respondents were non-Hispanic whites or Caucasian which was also expected [15]. Students in engineering and construction related degrees tend to be very similar demographically with 75% of the respondents being white male at these institutions and illustrated in Figures 3 and 4.

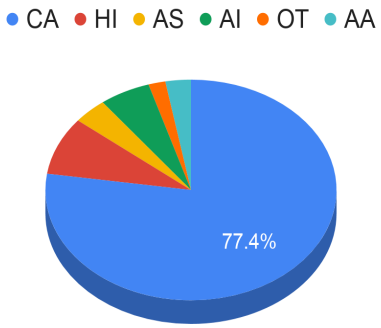

Figure 4 - Demographics Based on Race

The questions were assigned a code number to identify the questions in the graphs below. The question numbers on the surveys varied to limit survey funneling or central tendency bias [16]. A DC signifier was added to the question number to identify results to the same question when in a different order. Questions about the courses were based on a Likert scale from 1 equals Agree and 5 equals Disagree. It was evident during data collection and analysis that some respondents assumed the values in the Likert scale without reading the survey and then corrected many of the responses. Surprisingly, when comparing the questions with the responses, students and industry alike did not feel like their degree was required for their careers. DC2, DC6 and DC9 are the most positive responses as shown in Figure 5. DC2 indicates agreement that humanities are important to their future career. DC6 indicates agreement with structural courses are difficult to understand. DC9 indicates English literature courses are valuable.

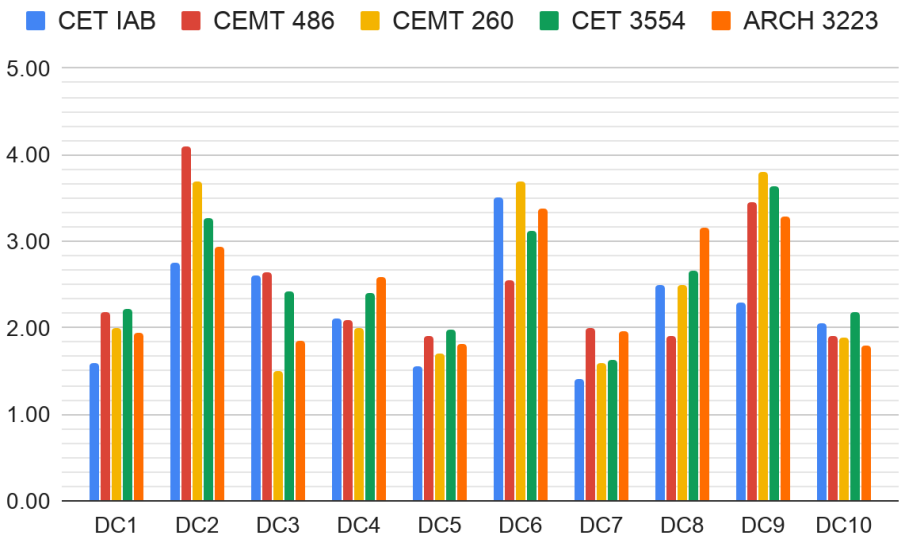

Figure 5 - Comparison of Survey Question Responses

Students were asked to self-report grades in courses associated with the perception responses. Grades were reformatted to a numeric system as shown in Figure 7 which is grade vs different course types. The maximum possible grades of courses are A, 100% and minimum possible grades of courses are D, 60%. The survey provided whole grades only, however, some students choose to report across multiple grades. Due to this, the lower grades will be used for analysis. When respondents did not self-report all of the grades, only the grades reported were included. As the respondents varied in their degrees and levels in college, the coursework they had completed also varied. Therefore not all respondents had taken all courses and could not report all of the grades.

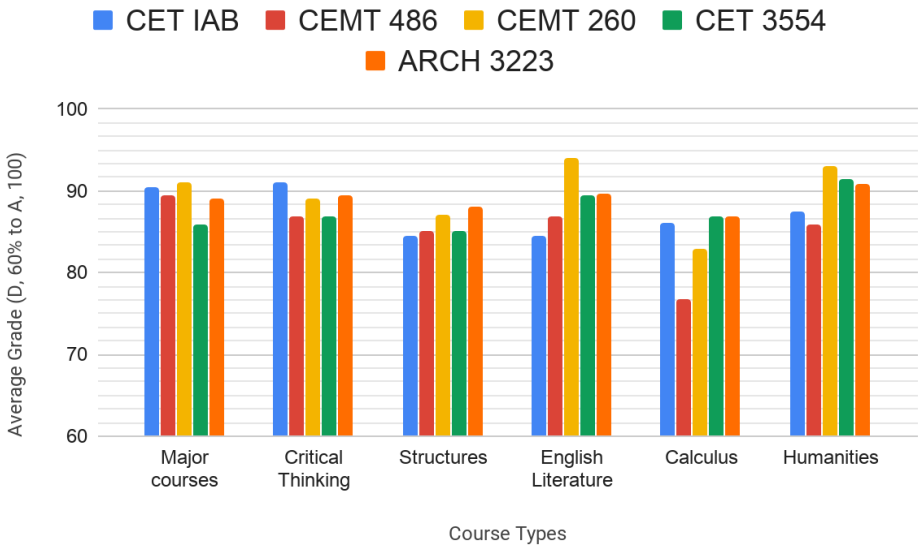

Figure 6 - Self-Reported Grades

Analysis

There are some significant responses which are worth noting. Students who do well in coursework, also report that the same coursework has value. When comparing statements DC3 "Structural design courses are relevant to my career after college." and grades in Structures courses, there was a χ^2=7.23, df=3, p=0.0253 for A's and p=0.0063 for B's. Similarly, DC7 "Critical thinking courses are important to my career." and grades in Critical Thinking courses, there is a χ^2=1.83, df=2, p=0.0025 for A's and p=0.0028 for B's.

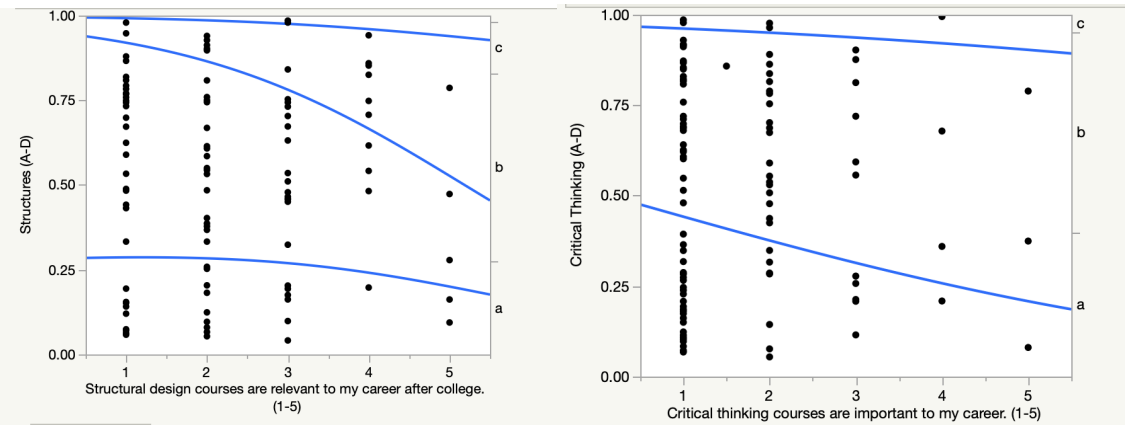

Figure 7 -Statistical analysis of structural design courses and critical thinking courses

Responses to questions about DC1 and DC5 major courses, and DC4 writing courses provide similar correlations. However, DC2 Humanities and DC9 English Literature courses did not have a statistically significant correlation. Is it expected that students would consider mathematically based courses and writing courses to have more impact than literature or humanities courses. When considering statement D10 "My degree is required for my career path." and comparing it to either Structures or Major courses grades, again there is statistical significance. Cramer's V was determined for all of these comparisons. Although the p-value indicates relevance, Cramer's V was determined and did not indicate a strong relationship. A larger sample group would be required in the future.

Additionally, a similar analysis was made comparing how female students responded versus male students to the importance of structures to their careers after college. Female respondents self-reported higher grades in all categories with the exception of critical thinking. This might be a reflection on the terminology used in the survey. Overall, however, there is not a statistically significant difference in perceptions on coursework and its relationship to career between male and female respondents.

View of IAB members, CM students and Architecture students regarding structure course work.

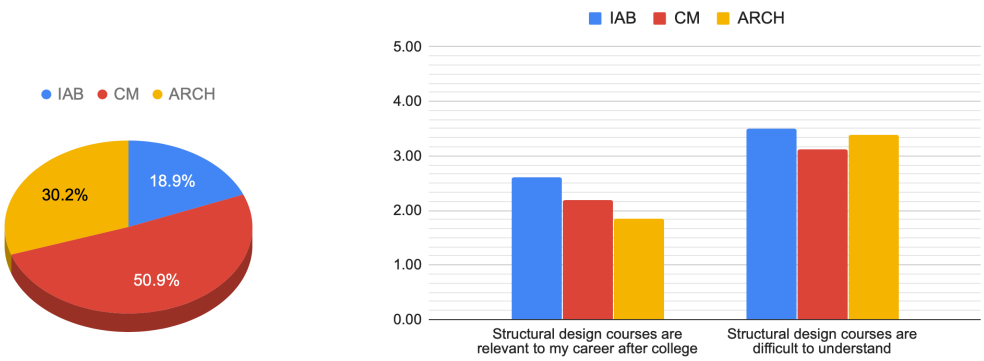

Figure 8 - Analysis of IAB, CM and Architecture regarding structural coursework

Recommendations and Conclusions

Attitude has previously been shown to be a predictor for grades [6], [7]. This research has additionally found that students who consider the coursework to be relevant or important self-report grades higher grades.

This research has focused on Structures courses as faculty had received feedback specifically about these courses. However, in order to determine if other courses illicit the same responses, another survey which is more broad-based could be employed. Another item of note is the concern with the Likert scale of 1-Agree to 5-Disagree. An additional check question should be employed on future surveys. Another option to limit survey funneling or central tendency bias which is frequently observed in survey responses moving to the center or more neutral responses from the beginning to end of the survey [16]. By utilizing multiple surveys with the same questions in different orders, the central tendency bias can be minimized.

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