A Comparison of Construction Management and Engineering Student Learning Styles

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This paper presents the findings of a study analyzing the learning styles of undergraduate construction management (CM) students in bachelor degree programs in the U.S. and compares them to engineering student learning styles. The study utilized the Felder-Silverman model and the Index of Learning Styles (ILS) as a survey instrument. The population of the students surveyed was 1,069 CM students from 36 university CM programs across the Associated Schools of Construction regions. Past studies with engineering students were utilized for the engineering student data. The results were analyzed and comparisons were made of both the CM students and other similar studies done with engineering students. It was found that CM students were visual, active, sensing, and sequential learners. They are also significantly higher in all the learning style dimensions than engineering students.

Introduction

The Architectural, Engineering, and Construction (AEC) industry is in a constant state of change reacting to changing economics, labor force, technology, and government regulations. The process of what is considered engineering and construction is expanding in the ever changing global market [3, 4]. To keep pace with industry, construction management programs must change the way they teach and prepare graduates for industry. Engineers and construction professionals now have to do more than just problem solve. They must be able to be innovative in design and execution, utilizing creative thinking along with understanding math and science principles. They must also be able to work within multidisciplinary teams of other industry professional and communicate effectively across those disciplines [4-7].

Another driving factor is that Engineering and Construction Management (CM) programs are also being required to change to meet the requirements of the accreditation bodies [8-12]. “The Council on Post-Secondary Accreditation in the US Department of Education has mandated that accrediting agencies use outcome assessments in evaluating their programs. As a result, the American Council for Construction Education (ACCE) and the Accrediting Board for Engineering and Technology (ABET) are including outcome assessment as part of their requirements for accreditation” [9]. Student performance is critical in meeting these outcome assessments and must be documented, along with student learning outcomes [7, 9, 12].

These factors point to a need to change the way engineering and construction education is being taught. Hauck [8] has argued that programs should make assessments and changes in a holistic fashion, assessing everything the program does. As student learning outcomes are assessed, it makes sense to also look at how the students learn. This is analogous to a company doing extensive marketing research to get to know everything there is to know about their client, and then tailoring their marketing, service, and business model to that client. Just as in marketing, engineering and CM programs need to know their students’ learning styles [13]. Many engineering programs already have done this and have changed how they teach engineering students. [13, 14]. In review of the literature, there are many studies that have been done on learning styles of engineering undergraduate students [13, 15-17]. However very few studies of this type have been done on CM undergraduate students. Only two studies were found that
examined learning styles in a small population of CM students, with the focus on difference of learning styles between students and faculty [18, 19]. There has not been any studies comparing CM learning styles and engineering learning styles. The lack of studies in this area indicates a gap in the literature. This study was designed to examine the learning styles of a larger population of CM students from across the U.S. and compare them to engineering learning styles to fill the gap.

Research Questions

The research questions for this study were; 1. What are the learning styles of undergraduate students in four year CM curriculum programs? 2. How do CM student learning styles compare with other engineering student learning style studies [13, 18, 20, 21], to determine if there is a difference between learning styles specific to CM students and engineering students, as has been called for by Felder and Brent [13].

Review of Literature

When discussing learning styles, one must look to theory and original research about learning styles and how people learn. Kolb [23,24] based his research and the development of experiential learning theory (ELT) and individual learning styles on the work of Dewey, Jung, Lewin, and Piaget [22]. Kolb defined ELT and learning as “the process whereby knowledge is created through the transformation of experience” [23]. Through the process of learning by experiences, instead of behavioral outcomes, each students’ learning style is different, based on their past experiences [23].

Since each students’ personalities and experiences were specific to each individual, Kolb argues that they would also have individual learning styles. He developed the Learning Style Inventory (LSI) and analyzed the learning styles of 800 practicing managers and graduate students in management. He found that though they shared similar careers, they have varying learning styles that were associated with their undergraduate training; engineering verses science verse humanities field of studies [24]. Learning styles have been described in many different ways, however most definitions express it as the preferential way an individual perceives and processes information. Just as there are different personalities, there are also different ways that people prefer to learn, especially the newer generation of college students [4, 13, 17, 18, 23, 25-27].

Learning styles have been theorized and studied for many years. Hall and Mosley [28] found 71 different learning style instruments and 800 papers discussing learning styles. Coffield et al found thousands of papers in a 16 month comprehensive review of learning style literature, which is widely cited by both proponents for and against learning styles [28-30]. They reviewed 13 of the most popular learning style models and measurement tools, and concluded that the type of learning style assessment method utilized was very important, that learners and teachers should be concerned with learning style research, and that much more research must be performed in the area of learning style effectiveness. When performing their analysis of learning style research, Pashler et al. [32] concluded that the literature did not provide enough empirical evidence to apply learning style assessment in school settings. They and others have concluded that the practicality of classification of student learning styles has yet to be demonstrated; that
there does not seem to be a link between learning styles and student achievement and that more research is needed. [31-37]. Strong proponents against learning styles cite the studies done by Coffield et al. [29] and Pashler et al. [32] as evidence that the concept of learning styles should be abandoned, even though the two studies concluded that more research and evidence is needed. Scott (2010) went as far as to say that classifying students in learning style categories are labeling, stereotyping, and harmful teaching practices [38-41]. Despite the questioning of the application of learning style research and assessment tools in the classroom, learning style assessment is still widely utilized in classroom settings in many different types of courses.

Of the many models, there are three learning style models that are utilized in engineering education [13, 16, 42, 43]. The first is Kolb’s Learning Style Model [23]. Learners are classified into four types. Type 1 are concrete and reflective. They ask “why” and want to connect how course materials relate to their experience, interest, and future careers. Type 2 are abstract and reflective. They ask “what” and connect with information that is presented in an organized and logical order. They will then think about the information and how it applies to them. Type 3 are abstract and active. They ask “how” and respond by hands-on trial and error applications. Type 4 are concrete and active. They ask “what if” and want to try the new materials out for themselves.

The second model is the Myers-Briggs Type Indicator (MBTI). Though technically it is a personality indicator, it is frequently used as a learning style correlation. It classifies students into four main scales based on psychological types; Extraverts vs Introverts, Sensors vs Intuitors, Thinkers vs Feelers, and Judgers vs Perceivers. Extraverts are those who try things out, while Introverts think things through. Sensors are practical and focus on facts and procedures, while Intuitors are imaginative and focus on meanings and possibilities. Thinkers make decisions based on logic and rules, while Feelers make decisions based on personal feelings and experiences. Judgers follow set agendas and make decisions even with incomplete data, while Perceivers adapt to changing circumstances and always look for more data [16, 42].

The third learning style model is the Felder-Silverman Index of Learning Styles (ILS) [2, 44]. The model categorizes eight different learning styles in four different dimensions along contrasting scales; active learners versus reflective learners, sensing learners versus intuitive learners, visual learners versus verbal learners, and sequential learners versus global learners. Table 1 is an example of the ILS results display given to participants.
On the ILS scale, if a student scores between one and three either direction; they are considered balanced on the two dimensions of the scale. If they score a five to seven, they have a moderate preference towards that learning style. If they score a nine to 11, they have a very strong preference towards that learning style and may struggle learning in an environment of the opposite style. Of the many different models and indexes, the Felder-Silverman ILS model examines visual learning style, which is a common theme in science, technology, engineering, and mathematics (STEM) research [17].

Franzoni and Assar [1] took the ILS model, its eight categories and four learning style dimensions, and ordered them in the steps that learning happens. The first learning style dimension (LSD) is the students’ preferred Entry Channel (LSD1); how they receive the information. Are they visual learners verses verbal learners? Visual learners retain and understand by what they see. They prefer watching TV over reading a book. In contrast, verbal learners are the polar opposites. They retain and understand by what they hear or read. They prefer reading a book over watching TV [1, 2, 45-47].

The second learning style dimension is the students’ Processing (LSD2) of the information. Are they active learners versus reflective learners? Active learners retain and understand by doing and learning hands-on. They are the type to try something out before thinking things through. They prefer to work together in groups and enjoy interactive projects. Reflective learners retain and understand by thinking about it first. They think about the steps involved to reach the solution before acting. They also prefer to work alone [1, 2, 45-47].

The third learning style dimension is the students’ Perception (LSD3) of the information given them. Are they sensing learners versus intuitive learners? Sensors like to learn facts and solve problems with established methods and formulas. They dislike courses that have little apparent connection to the real world. Intuitors prefer learning possibilities, relationships, and abstract concepts and think how they can be applied to other situations. They like innovation and dislike repetition and “plug-and-chug” course work with lots of memorization and calculations [1, 2, 45-47].
The fourth learning style dimension is the students’ Understanding (LSD4) of the information. Are they sequential learners versus global learners? Sequential learners retain and understand in a linear fashion, through step by step logical process. They may not understand the entire solution, but they can start working through the steps of the problem and work with the data. Global learners can grasp the big picture and absorb large amounts of material before they “get it”. They can solve complex problems quickly, but may have difficulty explaining how they did it [1, 2, 45-47]. Table 2 shows the learning style dimensions (LSD) in order of how learning happens.

Table 2 Learning Style Dimensions - Source: [1, 2]

<table>
<thead>
<tr>
<th>Learning Style Dimension</th>
<th>Scale Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSD1 Entry Channel</td>
<td>Visual</td>
<td>Easy for them to remember what they see: images, diagrams, time tables, films, etc.</td>
</tr>
<tr>
<td></td>
<td>Verbal</td>
<td>Remember what they’ve heard, read, or said.</td>
</tr>
<tr>
<td>LSD2 Processing</td>
<td>Active</td>
<td>Learn by working in groups and handling stuff.</td>
</tr>
<tr>
<td></td>
<td>Reflective</td>
<td>Learn better when they can think and reflect about the information presented to them. Work better alone or with one more person at most.</td>
</tr>
<tr>
<td>LSD3 Perception</td>
<td>Sensing</td>
<td>Rather deal with facts, raw data and experiments, they’re patient with details, but don’t like complications. They want connection to real the world.</td>
</tr>
<tr>
<td></td>
<td>Intuitive</td>
<td>Rather deal with principles and theories, are easily bored when presented with details and tend to accept complications.</td>
</tr>
<tr>
<td>LSD4 Understanding</td>
<td>Sequential</td>
<td>Follow a lineal reasoning process when solving problems and can work with a specific material once they’ve comprehended it partially or superficially</td>
</tr>
<tr>
<td></td>
<td>Global</td>
<td>Take big intuitive leaps with the information, may have a difficulty when explaining how they got to a certain result, need an integral vision.</td>
</tr>
</tbody>
</table>

The Felder-Silverman ILS has been utilized in many studies of engineering students. It was developed by Dr. Felder, a professor of chemical engineering and initially utilized in his chemical engineering classes. Since its creation, it has been used in most disciplines of engineering study. In a search of the ASEE conference proceeding from 2000 to 2006, Litzinger et al. [30] found hundreds of articles on learning styles and nearly 50 utilized the ILS in their classroom and research. The ILS is a respected and well know instrument in the engineering education industry. It is also considered to be easily administered and more easily understood by its participants than other learning style inventory instruments [2, 21, 30, 46, 48-51].

Learning styles have been utilized in research with many different undergraduate students in the engineering disciplines, [13, 15-17, 21], however only two studies have been found regarding learning styles and CM undergraduate students [18, 19]. The first study by Abdelhamid [18] utilized the ILS to examine the learning styles of the CM students in relation to the learning style of the CM faculty in their CM program at Michigan State University. Through a pilot study, they gave the ILS to seven students and one instructor to determine if there was a gap between students’ learning styles and faculty members’ learning styles. This led to a further study with a
test population of 277 students and five instructors. Along with the ILS, they created their own additional measurement tool to attempt to assess the students’ attitude toward the teaching mode/style of the instructors in the classroom. No testing of the reliability or validity of their assessment tool was discussed in their paper. Although they administered the ILS, they spent very little time discussing the results of the ILS and the majority of their discussion was the results of their assessment tool collected data. They did perform a t-test to analyze the difference between the students’ learning styles and the students’ attitude to the preferred teaching methods of the instructor (ILS vs their own assessment tool), but they did not do any statistical analysis on either data set (ILS or their own assessment tool), claiming that the large number of participants (277 students and five instructors) made the detailed analysis “of the data collected and results encyclopedic” [18]. The researchers collected the ILS data on the students, but their analysis and discussion were based on color graphs with the learning styles plotted on a scale not consistent with other ILS studies and results. Although the students were categorized by year in school, there was not any analysis to examine if there was any significant association between the learning styles of CM students and their year in school. The rest of the paper was a discussion of their unproven measurement tool and its results [18]. They only reported the mean scores for the ILS results of the students, not the actual percentages of each learning style dimension, so it was difficult to compare their results with the results of other studies.

The study by Harfield et al. [19] was done with a population of 153 New Zealand construction students. The population was described as a diverse group ranging from degree level final year students to students in a carpentry diploma program to certificate-level students in a pre-carpentry course. In their analysis, they did not separate the students by program type, year in school, or age. They used the Productivity Environmental Preference Survey (PEPS). According to Coffield et al. [52], the PEPS identifies 16 different components of learning styles and productivity by identifying the conditions which a learner is most likely learning in occupational or educational activities. Not only does it measure the perceptual preferences (auditory, visual, tactile, and kinesthetic), but also immediate environmental (sound, temperature, light, and design of the space), emotional factors (motivation, persistence, and structure or flexibility of the learner), sociological needs (prefers to work alone or with peers, authority oriented or against), and physical needs (food intake, time of day, physical condition). Coffied et al. [52] reviewed this model and claimed that it makes simplistic connections to complicated physiological and psychological preferences and needs to be further studied and validated before they could recommend its use in the United Kingdom. Since it measures many other factors such as the students’ surroundings or physical needs at the time of testing, which the ILS does not, comparing the results of the two models and instruments (ILS vs PEPS) is very complicated [29].

Extensive research has been done on engineering disciplines to determine the students’ learning styles utilizing the ILS as a measurement tool. There is a lack of research on learning styles using the same methodology focused on construction management students, in a traditional construction management four year college programs. This study focused on contributing to the body of knowledge about CM student learning styles and comparing them to engineering student learning styles.

Methodology
This research study was an experimental quantitative study, utilizing the existing learning styles model and measurement tool of the Felder-Silverman Index of Learning Styles (ILS) to assess the learning styles of CM students [2]. Using the same methodology as in previous studies in the engineering disciplines [13, 15, 16, 21], this study focused on CM students instead of students from engineering disciplines, as called for by Felder and Brent (2005).

The population of the full study was undergraduate and graduate college students in CM programs that were members of the ASC for the spring semester 2015. The participant sample of the full study was chosen based on their related discipline (purposive sampling) and because they were available (convenience). Purposive and convenience sampling has been standard practice in student learning style research [2, 16, 18, 19, 21, 43, 53, 54]. The goal was to obtain a very large sample population in order to have a large sample size for each of the student demographic subgroups. A list of 203 faculty from 131 universities that were listed as ASC members from the seven ASC regions across the nation was compiled. Of the 131 universities invited to participate with the study, 36 universities responded with participants (27% university response rate). Because of FERPA regulations, there was no access to the participating university students email contacts, so the study conduct relied on the participating university faculty to send the email survey link to their student body. From the beginning of the spring semester in January 2015, through the end of March 2015, a survey invitation was emailed once a week to the participating faculty, who then forwarded it on to their student body. See Appendix A for the complete list of participating schools.

To analyze the learning style of the students, the Index of Learning Styles (ILS) Assessment Tool of Soloman & Felder [44] was utilized for this study. According to Litzinger et al. [30], a search of the ASEE conference proceedings from 2000 to 2006 returned hundreds of articles on learning styles. Within those articles, nearly 50 used the ILS as a measurement instrument [30]. The ILS was chosen for this study because of the large number of engineering studies and one CM student study that was very similar to this research study that utilized it as a research instrument. This way parallel comparisons could be made since the same learning style instrument was utilized for all of the engineering studies [16, 18, 55].

The ILS is comprised of 44 questions that determine the participants learning style preference and strength of that preference on four different dimensions. Each question is comprised of two possible answers with 11 questions dedicated to each of the four learning style dimensions: visual vs verbal, active vs reflective, sensing vs intuitive, sequential vs global [2, 18, 21]. The ILS was also chosen because there have been multiple studies on the validity and reliability of the instrument. Each section within the ILS has been proven to have an internal consistency reliability coefficient greater than the 0.50 minimum coefficient set for assessments of preferences and attitudes. The LSD1-Entry Channel: visual vs verbal and LSD3–Perception: sensing vs intuitive have a reliability coefficient in excess of 0.70. The LSD2–Processing: active vs reflective has a reliability coefficient of 0.61 and the LSD4–Understanding: sequential vs global has a 0.55 reliability coefficient [30, 56]. There is also strong evidence that the ILS has good construct validity from both student feedback and factor analysis. It has a strong correlation between test and retest, with some studies going as long as eight months between test and retest scoring. The ILS has also been utilized in multiple studies since 1988 and has proven itself historically in multiple fields of research [15, 20, 30, 56, 57]. See Appendix B for the ILS.
Although past studies about the learning styles of students gave the survey instrument to the students during class time, utilizing in course survey data collection methodology [21, 58, 59], this study utilized online survey data collection methods and strategies [60-65]. The participating population sample was emailed a link to the Qualtrics online survey platform to collect their demographics and their ILS survey responses. The first part of the survey collected the student demographical information without collecting any identifying information. The second part of the survey was the unmodified Index of Learning style questions. Within the Qualtrics survey, the participant’s responses to the ILS questions were compiled. At the end of the survey, each participant’s personal ILS results were computed and reported back to them, along with the web link to the explanation of what their learning styles mean [66]. Qualtrics recognizes IP addresses, so students could only take the survey once [67]. At no point was any identifying information collected that could connect the participant to the results. On average, it took the participants ten minutes to complete the survey.

The data was collected through Qualtrics and exported into an Excel spreadsheet, which was then imported into SPSS statistical software. Since the data collected in this study was categorical, the statistical analysis performed was a Pearson’s Chi Square to analyze and determine if there is a significant association between the learning styles of the students and their demographics [21, 49, 68-72].

Since human subjects was utilized for this study, IRB approvals through the University of Nebraska – Kearney for the pilot study, and Purdue University for the full study, were required (See Appendix C for the approval letters). To protect the participants, the very first screen of the survey was an informed consent page. They were informed that their participation was voluntary and they did not have to participate, that the purpose of the survey was to collect data and examine what the learning styles are for students, and no identifying information (e.g., name, student ID, SS#) would be collected from them as participants. To move forward with the survey, participants had to click “YES” or “NO” that they had read and understood the consent form. At a click on “YES”, the participants were allowed to move on into the rest of the survey. At a click on “NO”, the participants were sent to a thank you and goodbye screen. They were also given the opportunity to print out the consent form for their records. See Appendix D for a copy of the email letter and survey consent form each participant received.

Conclusions and Discussion

For the data collection phase of this study, the population sample was emailed a link for the demographics and ILS survey through the use of Qualtrics online survey platform. The first part of the survey collected the student demographical information without collecting any identifying information. The second part of the survey was the unmodified Index of Learning Style (ILS) questions. Within the Qualtrics survey, the participants’ responses to the ILS questions were compiled and the participants ILS results were recorded in a separate field, along with their raw responses to the questions. These results were then downloaded in an Excel data file from Qualtrics. Once the file was downloaded the ILS results from each participant was coded in the proper ILS Learning Style Dimension (LSD).
The final download of the Excel data included 1,313 responses from 36 different schools across the nation. Within the 1,313 responses, there were 106 incomplete surveys, which gave the survey an 8% dropout rate. After the incomplete surveys were removed, there were a total of 1,207 complete survey responses. The total number of email survey requests that were sent out from the participating school faculty members is unknown, since there was no access to the 36 participating university CM program’s student body. The data was separated into the four Learning Styles: visual vs verbal, active vs reflective, sensing vs intuitive, and sequential vs global. Once the data was sorted, descriptive statistical analyses were performed. Then the data was analyzed with SPSS statistical software. Because the data was categorical, describing the frequency with which each category appears, Person Chi-Square analysis was run for each learning style dimension, to determine if there was a significant association between the variables. The data had to meet two assumptions for the Pearson Chi-Squared test. It had to be independent (not a repeated measures test), and the expected counts had to be greater than five. If the expected counts were less than five, the assumption was not met. At that point, there is significant reduction in the power of the test and it is not worth running the analysis. If the assumption of expected counts greater than five was met, the Pearson Chi-Squared test was valid and further analysis could be performed. If the assumption was not met, then the analysis was stopped. Phi and Cramer’s V was included in the data analysis to determine the effect of sizes. A z-test, or standardized residuals, was utilized by calculating the observed and expected counts, to determine specifically which variable was significantly associated [72].

There were a total of 1,207 complete survey responses. When sorted by majors, the participant population consisted of 91% (1,100) CM majors, 4% (44) engineering majors, 3% (34) interior design majors, 1% (14) architect majors, and 1% (15) other declared majors. Figure 1 shows the breakdown of the participants by major.

Since this study focused on the learning styles of CM students, the other majors were removed prior to analysis. This left a total of 1,100 CM majors to analyze. Of those, 3% (31) were graduate students. Because of the small populations size relative to the full population, and that many past research study participants in the literature review were undergraduate students, the graduate students were removed from the data. This left a sample population of 1,069 undergraduate CM students.
The results indicate that 93% of the CM undergraduate students moderately to strongly prefer the visual entry channel information over verbal entry channel information for the LSD1-Entry Channel: visual vs. verbal dimension. They remember more about what they see (e.g. images, diagrams, drawings, plans), than what they hear or read. For the LSD2-Processing: active vs reflective, 72% had a moderate preference to actively process the information more than reflecting upon it. They learn more by doing and working hands-on, not by thinking about the materials. They also like working in groups. For the LSD 3-Perception: sensing vs intuitive, 83% had a moderate preference for being sensing than intuitive in their perception of the information. They would rather deal with facts and raw data and not with principles or theories. They like real world coursework and solutions. They are patient going through step by step processes. For the LSD4-Understanding: sequential vs global, 66% had a balanced preference for sequential understanding. They follow linear reasoning and thinking when working through a problem, but of all the learning style dimensions, they are more balanced and can globally see the big picture of what the process accomplishes.

This group represented the total majority at 79% of the CM population. These results concur with the previous study by Abdelhamid [18] and the learning styles of CM students as determined using the ILS [18]. This study results, along with Abdelhamid [18] indicates that CM students do have similar learning styles. These results are also very similar to the results of engineering student studies [15, 20, 48, 51]. Table 3 summarizes the majority average CM learning styles on the ILS scale.

<table>
<thead>
<tr>
<th>LSD1 Entry Channel</th>
<th>LSD2 Processing</th>
<th>LSD3 Perception</th>
<th>LSD4 Understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>VISUAL</td>
<td>ACTIVE</td>
<td>SENSING</td>
<td>SEQUENTIAL</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>11 9 7 5 3 1 1 3 5 7 9 11</td>
<td>11 9 7 5 3 1 1 3 5 7 9 11</td>
<td>11 9 7 5 3 1 1 3 5 7 9 11</td>
<td>11 9 7 5 3 1 1 3 5 7 9 11</td>
</tr>
</tbody>
</table>

One of the objectives of this study was to compare the results of this study with engineering student learning style studies, to determine if there is a difference between learning styles specific to CM students and engineering students, as has been called for by Felder and Brent [13, 20, 21]. Felder and Brent [13] compiled the results of 15 engineering student learning style studies reported a total n=2,506 and their percentages for each of the learning style dimensions. Though both CM students and engineering students were classified as visual, active, sensing, and sequential, there were significant differences as to the level of the preferences between the two student groups. Table 4 shows the learning style percentages for CM and engineering students that were compared.
Table 4 CM vs ENG Student Learning Styles

<table>
<thead>
<tr>
<th>Learning Style Dimension</th>
<th>This Study CM n=1069</th>
<th>Felder &amp; Brent (2005) ENG n=2506</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry Channel (LSD1)</td>
<td>Visual: 93% (998)</td>
<td>Visual: 82% (2055)</td>
</tr>
<tr>
<td></td>
<td>Verbal: 7% (71)</td>
<td>Verbal: 18% (451)</td>
</tr>
<tr>
<td>Processing (LSD2)</td>
<td>Active: 72% (769)</td>
<td>Active: 64% (1604)</td>
</tr>
<tr>
<td></td>
<td>Reflective: 28% (300)</td>
<td>Reflective: 36% (902)</td>
</tr>
<tr>
<td>Perception (LSD3)</td>
<td>Sensing: 83% (882)</td>
<td>Sensing: 63% (1579)</td>
</tr>
<tr>
<td></td>
<td>Intuitive: 17% (187)</td>
<td>Intuitive: 37% (927)</td>
</tr>
<tr>
<td>Understanding (LSD4)</td>
<td>Seq.: 66% (710)</td>
<td>Seq.: 60% (1504)</td>
</tr>
<tr>
<td></td>
<td>Global: 34% (359)</td>
<td>Global: 40% (1002)</td>
</tr>
</tbody>
</table>

A Pearson Chi-squared was run to analyze the CM students’ learning style preferences in comparison to the engineering students’ learning style preferences. For the LSD1-Entry Channel: visual vs verbal, there was a significant association for this learning style dimension between CM students and engineering students, $X^2 (1) = 77.485, p < .001, r = .147$, small effect size. The CM students were significantly more visual and significantly less verbal than engineering students and engineering students were significantly more verbal than CM students. This indicates that CM students have a higher visual entry channel preference than engineering students. Even though the overall preference for engineering students was a visual entry channel, there were significantly more engineering students who had a verbal entry channel preference than CM students.

For the LSD2-Processing: active vs reflective, there was a significant association for this learning style dimension between CM students and engineering students, $X^2 (1) = 21.114, p < .001, r = .077$, small effect size. CM students were significantly more active and significantly less reflective than engineering students, and engineering students were significantly more reflective than CM students. This indicates that CM students would learn better working hands-on with the materials more than reflective thinking about the materials compared to engineering students. Even though the engineering students would be classified as active processors, they were more reflective processors than CM students.

For the LSD3-Perception: sensing vs intuitive, there was a significant association for this learning style dimension between CM students and engineering students, $X^2 (1) = 132.809, p < .001, r = .193$, small effect size. CM students were significantly more sensing and significantly less intuitive than engineering students, and engineering students were significantly less sensing and significantly more intuitive than CM students. This indicates that CM students would rather deal with facts and raw data more than engineering students. Engineering students would rather deal with principles and theories more than the CM students.

For the LSD4-Understanding: sequential vs global, there was a significant association for this learning style dimension between CM students and engineering students, $X^2 (1) = 13.024, p < .001, r = .060$, small effect size. CM students were significantly more sequential and significantly less global in their understanding of the information than engineering students. This indicates that the CM students followed a more linear reasoning or thinking process than the engineering students.

Overall, even though both CM students and engineering students were classified as the same learning style dimensions of verbal, active, sensing and sequential learners, CM students were significantly higher on all four of the learning style dimensions. This indicates that CM students
think and learn similarly to engineering students, yet they are different enough to warrant specific focus on CM learning styles and education. Because CM students are visual, active, sensing, and sequential learners, more so than engineering students, this impacts many things in the CM industry. For example, incorporating labs that have more hands on applications of construction practices will appeal to the learning styles of CM majors. Following in the footsteps of engineering student education, CM student and educators can become more in tune with their learning styles and change how CM education is taught.

The impacts of aligning the teaching style of engineering and CM programs and instructors with the learning styles of their students is that programs will produce more and better trained graduates. By lowering the dropout rate, more students will graduate and enter the industry. They will be better trained and prepared to begin their on the job training, with an understanding of how they learn. They will enter the industry as lifelong learners. Their learning styles impact and understanding doesn’t end with their graduation and college career. It is just as important for industry trainers to know their new hire’s learning styles, and align their industry training teaching styles to match.

There are many more questions that come up from this study for future research. Since this study focuses on the engineering and construction of the AEC student, what about the learning styles of architects? How do they compare with their engineering and construction student counterparts? Do the learning styles of different design disciplines differ, or are they the same? How can AEC education change from knowing the learning styles of its students?

References


## Appendix A. Associated Schools of Construction (ASC) Participating Schools

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Appendix B. Index of Learning Styles

Index of Learning Styles Questionnaire

Copyright © 1991, 1994 by North Carolina State University (Authored by Richard M. Felder and Barbara A. Soloman). For information about appropriate and inappropriate uses of the Index of Learning Styles and a study of its reliability and validity, see www.ncsu.edu/felder-public/ILSpage.html

Enter your answers to every question on the ILS scoring sheet. Please choose only one answer for each question. If both “a” and “b” seem to apply to you, choose the one that applies more frequently.

1. I understand something better after I
   □ a) try it out.
   □ b) think it through.

2. I would rather be considered
   □ a) realistic.
   □ b) innovative.

3. When I think about what I did yesterday, I am most likely to get
   □ a) a picture.
   □ b) words.

4. I tend to
   □ a) understand details of a subject but may be fuzzy about its overall structure.
   □ b) understand the overall structure but may be fuzzy about details.

5. When I am learning something new, it helps me to
   □ a) talk about it.
   □ b) think about it.

6. If I were a teacher, I would rather teach a course
   □ a) that deals with facts and real life situations.
   □ b) that deals with ideas and theories.
7. I prefer to get new information in
   - [ ] a) pictures, diagrams, graphs, or maps.
   - [ ] b) written directions or verbal information.

8. Once I understand
   - [ ] a) all the parts, I understand the whole thing.
   - [ ] b) the whole thing, I see how the parts fit.

9. In a study group working on difficult material, I am more likely to
   - [ ] a) jump in and contribute ideas.
   - [ ] b) sit back and listen.

10. I find it easier
    - [ ] a) to learn facts.
    - [ ] b) to learn concepts.

11. In a book with lots of pictures and charts, I am likely to
    - [ ] a) look over the pictures and charts carefully.
    - [ ] b) focus on the written text.

12. When I solve math problems
    - [ ] a) I usually work my way to the solutions one step at a time.
    - [ ] b) I often just see the solutions but then have to struggle to figure out the steps to get to them.

13. In classes I have taken
    - [ ] a) I have usually gotten to know many of the students.
    - [ ] b) I have rarely gotten to know many of the students.

14. In reading nonfiction, I prefer
    - [ ] a) something that teaches me new facts or tells me how to do something.
    - [ ] b) something that gives me new ideas to think about.

15. I like teachers
    - [ ] a) who put a lot of diagrams on the board.
    - [ ] b) who spend a lot of time explaining.

16. When I’m analyzing a story or a novel
a) I think of the incidents and try to put them together to figure out the themes.
b) I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17. When I start a homework problem, I am more likely to
   a) start working on the solution immediately.
   b) try to fully understand the problem first.

18. I prefer the idea of
   a) certainty.
   b) theory.

19. I remember best
   a) what I see.
   b) what I hear.

20. It is more important to me that an instructor
   a) lay out the material in clear sequential steps.
   b) give me an overall picture and relate the material to other subjects.

21. I prefer to study
   a) in a study group.
   b) alone.

22. I am more likely to be considered
   a) careful about the details of my work.
   b) creative about how to do my work.

23. When I get directions to a new place, I prefer
   a) a map.
   b) written instructions.

24. I learn
   a) at a fairly regular pace. If I study hard, I’ll “get it.”
   b) in fits and starts. I’ll be totally confused and then suddenly it all “clicks.”

25. I would rather first
☐ a) try things out.
☐ b) think about how I’m going to do it.

26. When I am reading for enjoyment, I like writers to
☐ a) clearly say what they mean.
☐ b) say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember
☐ a) the picture.
☐ b) what the instructor said about it.

28. When considering a body of information, I am more likely to
☐ a) focus on details and miss the big picture.
☐ b) try to understand the big picture before getting into the details.

29. I more easily remember
☐ a) something I have done.
☐ b) something I have thought a lot about.

30. When I have to perform a task, I prefer to
☐ a) master one way of doing it.
☐ b) come up with new ways of doing it.

31. When someone is showing me data, I prefer
☐ a) charts or graphs.
☐ b) text summarizing the results.

32. When writing a paper, I am more likely to
☐ a) work on (think about or write) the beginning of the paper and progress forward.
☐ b) work on (think about or write) different parts of the paper and then order them.

33. When I have to work on a group project, I first want to
☐ a) have “group brainstorming” where everyone contributes ideas.
☐ b) brainstorm individually and then come together as a group to compare ideas.
34. I consider it higher praise to call someone
☐ a) sensible.
☐ b) imaginative.

35. When I meet people at a party, I am more likely to remember
☐ a) what they looked like.
☐ b) what they said about themselves.

36. When I am learning a new subject, I prefer to
☐ a) stay focused on that subject, learning as much about it as I can.
☐ b) try to make connections between that subject and related subjects.

37. I am more likely to be considered
☐ a) outgoing.
☐ b) reserved.

38. I prefer courses that emphasize
☐ a) concrete material (facts, data).
☐ b) abstract material (concepts, theories).

39. For entertainment, I would rather
☐ a) watch television.
☐ b) read a book.

40. Some teachers start their lectures with an outline of what they will cover. Such outlines are
☐ a) somewhat helpful to me.
☐ b) very helpful to me.

41. The idea of doing homework in groups, with one grade for the entire group,
☐ a) appeals to me.
☐ b) does not appeal to me.

42. When I am doing long calculations,
☐ a) I tend to repeat all my steps and check my work carefully.
☐ b) I find checking my work tiresome and have to force myself to do it.
43. I tend to picture places I have been
☐ a) easily and fairly accurately.
☐ b) with difficulty and without much detail.

44. When solving problems in a group, I would be more likely to
☐ a) think of the steps in the solution process.
☐ b) think of possible consequences or applications of the solution in a wide range of areas.

Sample Results from the ILS Online Survey

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Learning Style Results

- If your score on a scale is 1-3, you are fairly well balanced on the two dimensions of that scale.
- If your score on a scale is 5-7, you have a moderate preference for one dimension of the scale and will learn more easily in a teaching environment which favors that dimension.
- If your score on a scale is 9-11, you have a very strong preference for one dimension of the scale. You may have real difficulty learning in an environment which does not support that preference.