7-28-2017

The Learning Styles of Undergraduate Students in CM Bachelor's Degree Programs in the U.S.

Eric A. Holt

Christine Chasek

Mark Shaurette

Robert Cox

The Learning Styles of Undergraduate Students in CM Bachelor's Degree Programs in the U.S.

Eric A. Holt, PhD[a], Christine Chasek, PhD[b], Mark Shaurette, PhD[c] and Robert Cox, PhD[c]

[a]University of Denver, Denver, Colorado, USA; [b]University of Nebraska, Kearney, Nebraska, USA; [c]Purdue University, West Lafayette, Indiana, USA

To cite this article: Eric A. Holt, Christine Chasek, Mark Shaurette & Robert Cox (2018) The Learning Styles of Undergraduate Students in CM Bachelor's Degree Programs in the U.S., International Journal of Construction Education and Research, 14:1, 4-21, DOI: https://doi.org/10.1080/15578771.2017.1342718

ABSTRACT

This article presents the findings of a study analyzing the learning styles of undergraduate construction management (CM) students in bachelor's degree programs in the United States. The study utilized the Felder-Silverman model and the Index of Learning Styles (ILS) as a survey instrument. The survey population consisted of 1,069 CM students from 36 university CM programs across the Associated Schools of Construction regions. Demographic information, the raw ILS responses, and the ILS web-based survey report were collected from the students. The results were analyzed and compared to both the CM students themselves and to similar studies done with engineering students. It was found that CM students were visual, active, sensing, and sequential learners. This study provides recommendations for how CM instructors might align their teaching styles with CM-student learning styles, and discusses impacts on the CM industry.

KEYWORDS

Learning style; undergraduate CM students; index of learning styles

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 (Benhart & Shaurette, 2011; Bernold, 2005). To keep pace with industry, construction management programs need to change the way they teach to prepare graduates for industry. Engineers and construction professionals now have to do more than just problem solve. They must be innovative in design and execution, and utilize creative thinking along with math and science principles. They must also be able to work within multidisciplinary teams of other industry professionals and communicate effectively across those disciplines (Benhart & Shaurette, 2011; Bernold, 2005).

Another driving factor for Engineering and Construction Management (CM) programs is pressure to meet accreditation requirements (Andersen & Andersen, 1998; Bernold, 2007). The Council on Post-secondary Accreditation in the US Department of Education mandates that accrediting agencies use outcomes 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 outcomes assessment as part of their requirements for accreditation (Andersen & Andersen, 1998). Student performance is critical in meeting these assessment requirements and must be documented, along with student learning outcomes (Andersen & Andersen, 1998; Benhart & Shaurette, 2011).

These factors suggest a need to change the way engineering and construction education is being taught. Hauck (1998) 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 examine how CM students learn. This is analogous to a company doing extensive marketing research on a client, and then tailoring their marketing, service, and business model to suit that client. As in marketing, CM programs would benefit from knowledge about their students' learning styles (Felder & Brent, 2005). In the literature, many studies examine the learning styles of engineering undergraduate students (Felder & Brent, 2005; Felder & Spurlin, 2005). However, 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, focusing on differing learning styles between students and faculty (Abdelhamid, 2003; Harfield, Panko, Davies, & Kenley, 2007). The lack of studies in this area indicates a gap in the body of knowledge. To fill the gap, this study asked: What are the dominant learning styles of undergraduate students in 4-year CM curriculum programs?

Review of literature

When discussing learning styles, one must look to theory and original research about learning styles and how people learn. Kolb (1981, 1984) based his research and development of experiential learning theory (ELT) and individual learning styles on the work of Dewey, Jung, Lewin, and Piaget (A. Y. Kolb, Boyatzis, & Mainemelis, 2001). Kolb defined ELT and learning as “the process whereby knowledge is created through the transformation of experience” (Kolb, 1984). Through the process of learning by experience, instead of behavioral outcomes, each student’s learning style is different, based on past encounters (Kolb, 1984).

Kolb developed the Learning Style Inventory (LSI) through the analysis of 800 practicing managers and graduate students in management. He found that though they shared similar careers, they had varying learning styles associated with their undergraduate training: engineering vs. science vs. humanities fields of study (Kolb, 1981). Learning styles are the preferred ways individuals perceive and process information. Just as there are different personalities, there are different ways people prefer to learn—especially the newer generation of college students (Abdelhamid, 2003; Bernold, 2005; Felder & Brent, 2005; Kolb, 1984).

Researchers believe that learning styles impact how students receive and process information. They also agree that instructors are more effective when they consider student-learning styles as they develop curriculum and deliver course content. When instructors tailor course content and teaching style to the learning styles of their students, and students possess learning-style self-awareness, learning outcomes improve. Instructors become more efficient in their teaching, and students become more motivated, balanced, and involved in their learning (Abdelhamid, 2003; Bernold, 2005).

There are three learning-style models utilized in engineering education (Bernold, Bingham, McDonald, & Attia, 2000; Felder & Brent, 2005). The first is Kolb's Learning Style Model (Kolb, 1984). Learners are classified into four types. Type 1 learners are concrete and reflective. They ask "why" and want to connect course materials to their experience, interest, and future careers. Type 2 learners are abstract and reflective. They ask "what" and connect with information presented in an organized and logical order. They then think about the information and how it applies to them. Type 3 learners are abstract and active. They ask "how" and respond by hands-on trial-and-error applications. Type 4 learners are concrete and active. They ask "what if" and want to try new materials out for themselves (Kolb, 1984).

The second model is the Myers-Briggs Type Indicator (MBTI). Though MBTI is a personality indicator, it is frequently used as a learning-style correlation. It classifies students via four main scales based on psychological types: extroverts vs. introverts; sensors vs. intuitors; thinkers vs. feelers; and judgers vs. perceivers. Extroverts are those who try things out, while introverts think things through. Sensors are practical and focused on facts and procedures, while intuitors are imaginative and focused 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 (Bernold et al., 2000).

The third learning-style model is the Felder-Silverman Index of Learning Styles (ILS) (Felder & Silverman, 1988). The model categorizes eight different learning styles in four different dimensions along contrasting scales: active learners vs. reflective learners; sensing learners vs. intuitive learners; visual learners vs. verbal learners; and sequential learners vs. global learners.

Franzoni and Assar (2009) took the ILS model and organized them into the order in which learning happens. The first learning-style dimension (LSD) is the preferred Entry Channel (LSD1): how students receive the information. Are they visual learners or verbal learners? Visual learners retain information and understand concepts by what they see. They prefer watching television to reading a book. In contrast, verbal learners are the opposite. They retain and understand by what they hear or read. They prefer reading a book to watching TV (Felder, 1993; Felder & Silverman, 1988; Franzoni & Assar, 2009).

The second learning-style dimension is the mode of Processing (LSD2) information. Are they active learners or reflective learners? Active learners retain information and understand concepts by doing and learning in a hands-on fashion. They prefer to try something out before thinking it through. They work well in groups and enjoy interactive projects. Reflective learners retain and understand by thinking about it first. They consider the steps involved to reach a solution before acting. They also prefer to work alone (Felder, 1993; Felder & Silverman, 1988; Franzoni & Assar, 2009).

The third learning-style dimension is Perception (LSD3) of information. Are they sensing learners or intuitive learners? Sensors like to learn facts and solve problems with established methods and formulas. They dislike courses with little apparent connection to the real world. Intuitors prefer learning possibilities, relationships, and abstract concepts and process how they can be applied to other situations. They also favor innovation and dislike repetition and so-called “plug-and-chug” course work with excess memorization and calculations (Felder, 1993; Felder & Silverman, 1988; Franzoni & Assar, 2009).

The fourth learning-style dimension is the process of Understanding (LSD4) information. Are they sequential learners or global learners? Sequential learners retain and under- stand in a linear fashion, through a logical, step-by-step 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 arrived at a solution (Felder, 1993; Felder & Silverman, 1988; Franzoni & Assar, 2009).

Table 1 shows the learning-style dimensions (LSD) in order of how learning occurs.

Learning Style Dimension	Scale Type	Description
LSD1Entry Channel	Visual	Easy for them to remember what they see: images, diagrams, tables, films, etc.
	Verbal	Remember what they've heard, read, or said.
LSD2Processing	Active	Learn by working in groups and handling materials.
	Reflective	Learn better when they can think and reflect about the information presented to them. Work better alone or with one more person at most.
LSD3Perception	Sensing	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.
	Intuitive	Rather deal with principles and theories, easily bored when presented with details, and tend to accept complications.
LSD4Understanding	Sequential	Follow a linear reasoning process when solving problems and can work with a specific material once they've comprehended it partially or superficially.
	Global	Take big intuitive leaps with the information; may have difficulty when explaining how they got to a certain result, and need an integral vision.

On the ILS scale, if a student scores between one and three in either direction, they are considered balanced on the two dimensions of the scale. If they score between five and seven, they have a moderate preference towards that specific learning style. If they score between nine and 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 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.

Since its creation, the Felder-Silverman ILS has been routinely employed in engineering disciplines. Litzinger and colleagues (2007) 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-known instrument in the engineering education industry. It is easily administered and more easily understood by its participants than other learning-style inventory instruments (Litzinger, Lee, Wise, & Felder, 2007).

Table 2 is an example of the ILS results display given to participants.

	X												
VISUAL	11	9	7	5	3	1	1	3	5	7	9	11	VERBAL
						<-	->						
							X						
ACTIVE	11	9	7	5	3	1	1	3	5	7	9	11	REFLECTIVE
						<-	->						
				X									
SENSING	11	9	7	5	3	1	1	3	5	7	9	11	INTUITIVE
						<-	->						
								X					
SEQUENTIAL	11	9	7	5	3	1	1	3	5	7	9	11	GLOBAL
						<-	->						
	Strong		Mod		Balance		Balance		Mod		Strong		

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.

Multiple studies have examined the validity and reliability of the instrument. Each section within the ILS has proven to have an internal consistency reliability coefficient greater than the .50 minimum coefficient set for assessments of preferences and attitudes. LSD1–Entry Channel (visual vs. verbal) and LSD3–Perception (sensing vs. intuitive) have reliability coefficients in excess of .70. LSD2–Processing (active vs. reflective) has a reliability coefficient of .61 and LSD4–Understanding (sequential vs. global) has a .55 reliability coefficient (Litzinger et al., 2007). 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 taking as long as 8 months between test and retest scoring. The ILS has been utlized in multiple studies since 1988 and proven itself historically in mutiple fields of research (Felder & Spurlin, 2005; Litzinger et al., 2007; Zywno, 2003).

While learning styles have been utilized in research with many different undergraduate students in the engineering disciplines (Felder & Brent, 2005; Felder & Spurlin, 2005), only two studies have been found regarding learning styles among CM undergraduate students (Abdelhamid, 2003; Harfield et al., 2007). Abdelhamid (2003) utilized the ILS to examine the learning styles of CM students in relation to faculty learning styles in their CM program at Michigan State University. Although they administered the ILS, they spent very little time discussing the results of the ILS. They only reported the mean scores for student ILS results, not the actual percentages of each learning-style dimension, so it was difficult to compare their results with those of other studies.

Harfield and colleagues (2007) utilized the Productivity Environmental Preference Survey (PEPS), developed by Dunn and colleagues (1989). According to Coffield and colleagues (2004), PEPS identifies 16 components of learning style and productivity by classifying the conditions in which a learner is most likely learning in occupational or educational activities. Since PEPS measures factors that the ILS does not—such as student surroundings and physical needs at the time of testing—comparing results of the two models and instruments is problematic (Coffield, Moseley, Hall, & Ecclestone, 2004).

Extensive research has been done in engineering disciplines to determine student- learning styles via the ILS measurement tool. However, there is a lack of learning-style research using this methodology focusing on CM students in traditional CM programs at 4-year institutions. There is even less research on the demographics of CM students to determine if learning styles are impacted by demographics. This study focused on contributing to the body of knowledge about CM student learning styles and the roles they play in CM education.

Methodology

This research study was an experimental quantitative study, utilizing the existing learning- styles model and measurement tools of the Felder-Silverman Index of Learning Styles (ILS) to assess learning styles of CM students (Felder & Silverman, 1988). Using the same methodology as previous studies in the engineering disciplines (Felder & Brent, 2005; Felder & Spurlin, 2005), this study focused on CM students. The ILS was chosen for this study because of the availability of a 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.

The ILS tool comprises 44 questions designed to determine participants' learning-style preference and strength of that preference on four different dimensions. Each question offers two possible answers, with 11 questions dedicated to each of the four learning-style dimensions (LSD) and the eight preferences: LSD1–Entry Channel (visual vs. verbal), LSD2–Processing (active vs. reflective), LSD3–Perception (sensing vs. intuitive), and LSD4–Understanding (sequential vs. global) (Abdelhamid, 2003; Felder & Silverman, 1988).

The population for this research was undergraduate CM majors enrolled in 4-year university CM programs during the fall and spring 2014/2015 academic semesters. The pilot study sample consisted of approximately 94 undergraduate students from the University of Nebraska–Kearney CM program. This sample was utilized to test the data collection methods and refine the statistical model analysis. A large population sample (n) was desired to ensure that each demographic sub-group had a population sample greater than 30 for statistical analysis. The pilot study demonstrated the challenges of getting students to participate in the online survey. It took multiple requests from CM faculty over a 6-week period to collect enough participants to gather a population sample (n) greater than 30 (34 participants out of 94 students). The most effective strategy in increasing student participant numbers was offering the survey in class as extra credit or class assignment. Pilot study participants were chosen based on their related discipline (purposive) and because they were available for evaluation (convenience). Purposive and convenience sampling is standard practice in student learning style research (Abdelhamid, 2003; Andreou, Papastavrou, & Merkouris, 2013; Broberg, Lin, & Griggs, 2008; Chunduri, Zhu, & Bayraktar, 2011; Felder, 1996; Felder & Silverman, 1988; Fellows & Liu, 2009; Harfield et al., 2007).

The population of the full study was undergraduate and graduate college students enrolled in ASC-member CM programs during the spring 2015 semester, utilizing the same purposive and convenience sampling methodology as the pilot study. Of the 131 ASC-member universities invited to participate in the study, 36 universities responded with participants (27% university response rate). Because of FERPA regulations, there was no access to participating university students' email contacts, so the study relied on participating faculty to send the email survey link to their student body. From January 2015 through March 2015, a survey invitation was emailed once a week to the participating faculty, who then forwarded it to their student body. See Appendix A for a complete list of participating schools.

The participating population sample was emailed a link to the Qualtrics online survey platform to collect demographic information and ILS survey responses. The first part of the survey collected the student demographic information. The second part of the survey included the unmodified Index of Learning style questions. At the end of the survey, each participant's personal ILS results were computed and reported back to them, along with a web link to an explanation of the uses of the ILS model. Qualtrics recognizes IP addresses, so students could only take the survey once. At no point was any identifying information collected that could connect the participant to the results. IRB approval was obtained before beginning data collection.

The study collected 1,313 responses from 36 different schools across the United States. After filtering, the sample comprised 1,100 complete responses from CM students (31 graduate, 1,069 undergraduate). The graduate students were filtered from the study. The total number of email survey requests sent from participating school faculty members is unknown. The final population was sorted into demographic categories, which for the purpose of this study were region, academic year, gender, ethnicity, and age. It was also sorted into the four Learning Style Dimensions.

After the data were sorted, descriptive and analytical statistical analyses were per- formed. Because the data were categorical—describing the frequency with which each category appears—Pearson chi-square analysis was run for each learning-style dimension by student demographics (region, academic year, gender, ethnicity, and age). Phi and Cramer's V were included in the data analysis to determine the effect of sizes, and a *z*-test, or standardized residuals, was conducted to determine specifically which variable was significantly associated.

Results

The regional demographics of the CM population, determined by institutional enrollment, were spread across seven different areas, based on ASC regional boundaries. Region 1–Northeast provided 8% (85) of participant responses. Region 2–Southeast provided 17% (181) of participant responses. Region 3–Great Lakes provided 20% (219) of participant responses. Region 4–North Central provided the largest portion of participant responses, at 26% (282). Region 5–South Central provided 10% (106) of participant responses. Region 6–Rocky Mountains provided 14% (157) of participant responses, and Region 7–Far West had the fewest at 5% (51) of participant responses.

The academic year demographics of the CM population were categorized into fresh- men, sophomores, juniors, and seniors. Freshmen students represented 14% (152), sophomores represented 23% (241), juniors represented 29% (307), and seniors were the largest populations group at 33% (368).

The gender demographics of the CM population were also analyzed. Of the 1,069 CM undergraduate student participants, 87% (925) were male students, while 13% (144) were female students.

The ethnicities of the CM population were categorized as 84% (891) Caucasian, 4% (44) Black/African American, 4% (47) Hispanic/Latino, 3% (34) Asian, 2% (25) Mixed, 1% (12) Middle Eastern, 1% (12) Other, and .04% (4) Native American.

The age demographics of the CM population were categorized as 38% (410) 18–20 years old, 45% (480) 21–23 years old, 9% (96) 24–26 years old, and 8% (83) 27+ years old. The combination of students age 18–21 and 21–23 represent 79% (890) of the participants. The average age of the population in this study was 21 years old.

The research question this study attempted to answer is, what are the dominant learning styles of undergraduate students in 4-year construction management curriculum programs? The learning styles were categorized into four Learning Style Dimensions (LSD): LSD1–Entry Channel (visual vs. verbal), LSD2–Processing (active vs. reflective), LSD3–Perception (sensing vs. intuitive), and LSD4–Understanding (sequential vs. global).

LSD1–entry channel: visual vs. verbal

For the LSD1–Entry Channel (visual vs. verbal), 93% (998) of the student population had a visual entry channel, while only 7% (71) of the student populations had a verbal entry channel. Of the 93% (998) who had a visual entry channel, 14% (135) were balanced in their preference between visual and verbal, 35% (377) had a moderate preference for visual learning vs. verbal learning, and 45% (486) had a strong preference for visual learning. The mean preference for the visual learners was 7.43, with a mode of 9 and a range of 1 to 11. This indicates that CM students in this study had a moderate to strong preference for visual learning as their entry channel.

Among the 7% (71) with a verbal entry channel, 5% (57) were balanced in their preference between verbal and visual, 1% (10) had a moderate preference for verbal learning vs. visual learning, and 1% (4) had a strong preference for verbal learning. The mean preference for the verbal learners was 2.66, with a mode of 1 and a range of 1 to 11. This indicates that the verbal learning CM students were balanced between verbal and visual as their entry channel. Table 3 shows the percentages of the CM LSD1–Entry Channel: 93% visual vs. 7% verbal and the mean and mode preferences for the CM population on the ILS scale.

Table 3. CM LSD1-Entry Channel: 93% Visual (mod. Strong) vs &% Verbal (balanced).

Mean 7.43	X						X				Mean 2.66		
VISUAL	11	9	7	5	3	1	1	3	5	7	9	11	VERBAL
Mode 9	X						X				Mode 1		
	Strong		Mod		Balance		Balance		Mod		Strong		

LSD2–processing: active vs. reflective

For the LSD2–Processing (active vs. reflective), 72% (769) of the student population were active processors, while 28% (300) of the student population were reflective processors. Of those 72% (769) who process actively, 42% (326) were balanced in their preference between active and reflective processing, 40% (305) had a moderate preference for active processing vs. reflective processing, and 18% (138) had a strong preference for active processing. The mean preference for the active processors was 4.83, with a mode of 5 and a range of 1 to 11. This indicates that the active processing CM students had a moderate preference for active processing learning.

Of the 28% (300) who process reflectively, 72% (216) were balanced in their preference between reflective and active processing, 24% (72) had a moderate preference for reflective processing vs. active processing, and 4% (12) had a strong preference for reflective processing. The mean preference for the reflective processors was 3.10, with a mode of 1 and a range of 1 to 9. This indicates that the reflective processing CM students had a balanced, but slightly moderate preference for processing reflective learning. Table 4 shows the percentages of LSD2–Processing: 72% active vs. 28% reflective and the mean and mode preferences for the CM population on the ILS scale.

Table 4. CM LSD2-Processing: 72% Active (moderate) vs 28% Reflective (balanced).

Mean 4.83	X						X				Mean 3.1		
ACTIVE	11	9	7	5	3	1	1	3	5	7	9	11	REFLECTIVE
Mode 5	X						X				Mode 1		
	Strong		Mod		Balance		Balance		Mod		Strong		

Table 5. CM LSD3-Perceptions: 83% Sensing (moderate) vs 17% Intuitive (balanced).

Mean 5.75	X		X										Mean 3.17
SENSING	11	9	7	5	3	1	1	3	5	7	9	11	INTUITIVE
Mode 7	X						X				Mode 1		
	Strong		Mod		Balance		Balance		Mod		Strong		

LSD3–perception: sensing vs. intuitive

For the LSD3–Perception (sensing vs. intuitive), 83% (882) of the student population were sensing while 17% (187) of the student population were intuitive. Among the 83% (882) who were sensing, 32% (281) were balanced in their preference between sensing and intuitive perception, 41% (366) had a moderate preference for sensing perception vs. intuitive perception, and 27% (235) had a strong preference for sensing perception. The mean preference for the sensing perception was 5.75, with a mode of 7 and range of 1 to 11. This indicates that the sensing CM students had a moderate preference for sensing percep- tion learning.

Among the 17% (187) who were intuitive, 72% (134) were balanced in their preference between intuitive and sensing perception, 20% (38) had a moderate preference for intuitive perception vs. sensing perception, and 8% (15) had a strong preference for intuitive perception. The mean preference for the intuitive perception was 3.17, with a mode of 1 and a range of 1 to 11. This indicates that the intuitive CM students had a balanced preference for intuitive perception learning. Table 5 shows the percentages of LSD3–Perception: 83% sensing vs. 17% intuitive and the mean and mode preferences for the CM population on the ILS scale.

LSD4–understanding: sequential vs. global

For the LSD4–Understanding (sequential vs. global), 66% (710) of the student population were sequential thinkers, while 34% (359) of the student populations were global thinkers in their understanding. Among the 66% (710) who were sequential thinkers, 59% (417) were balanced in their preference between sequential and global understanding, 35% (249) had a moderate preference for sequential understanding vs. global understanding, and 6% (44) had a strong preference for sequential understanding. The mean preference for the sequential understanding was 3.71, with a mode of 1 and a range of 1 to 11. This indicates that the sequential understanding CM students had a balanced preference for sequential understanding.

Of the 34% (359) who were global thinkers, 68% (244) were balanced in their preference between global and sequential understanding, 30% (107) had a moderate preference for global understanding vs. sequential understanding, and 2% (8) had a strong preference for global understanding. The mean preference for global understanding was 3.12, with a mode of 1 and a range of 1 to 11. This indicates that the global understanding CM students had a balanced preference for global understanding learning. Table 6 shows the percentages of LSD4–Understanding: 66% sequential vs. 34% global and the mean and mode preferences for the CM population on the ILS scale.

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 dimension. They remember more about what they see (e.g., images, diagrams, drawings, plans), than what they hear or read. For LSD2–Processing, 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 material. They also like working in groups. For LSD 3–Perception, 83% had a moderate preference for sensing vs. intuitive response in their perception of the information. They would rather work with facts and raw data than with principles or theories. They like real-world coursework and solutions. They are patient working through step-by-step processes. For LSD4–Understanding, 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.

Table 6. CM LSD4-Understanding: 66% Sequential (moderate) vs 34% Global (balanced).

<table>
<tr><td>Mean 3.71</td><td colspan="6">X</td><td colspan="4">X</td><td colspan="3">Mean 3.12</td></tr>
<tr><td>SEQUENTIAL</td><td>11</td><td>9</td><td>7</td><td>5</td><td>3</td><td>1</td><td>1</td><td>3</td><td>5</td><td>7</td><td>9</td><td>11</td><td>GLOBAL</td></tr>
<tr><td>Mode 1</td><td colspan="6">X</td><td colspan="4">X</td><td colspan="3">Mode 1</td></tr>
<tr><td></td><td colspan="2">Strong</td><td colspan="2">Mod</td><td colspan="2">Balance</td><td colspan="2">Balance</td><td colspan="2">Mod</td><td colspan="2">Strong</td><td></td></tr>
</table>

This group represented the total majority at 79% of the CM population. These results concur with Abdelhamid (2003) and the learning styles of CM students as determined using the ILS (Abdelhamid, 2003). These results, along with Abdelhamid (2003), indicate that CM students do have similar learning styles. Further, these findings are similar to the results of engineering student studies (Felder & Spurlin, 2005; Zywno, 2003). Table 7 summarizes the majority average CM learning styles on the ILS scale.

Table 7. Average CM Learning Styles of the Majority CM Population.

LSD1	VISUAL			X										VERBAL
Entry Channel		11	9	7	5	3	1	1	3	5	7	9	11	
							<-	->						
					X									
LSD2 Processing	ACTIVE	11	9	7	5	3	1	1	3	5	7	9	11	REFLECTIVE
							<-	->						
					X									
LSD3 Perception	SENSING	11	9	7	5	3	1	1	3	5	7	9	11	INTUITIVE
							<-	->						
						X								
LSD4 Understanding	SEQUENTIAL	11	9	7	5	3	1	1	3	5	7	9	11	GLOBAL
							<-	->						
		Strong		Mod		Balance		Balance		Mod		Strong		

There will still be students who have different learning styles than the average or majority of the classroom. For this study's population sample, 21% of the CM students preferred the verbal, reflective, intuitive, and global sides of the learning style dimensions. What was also unique about this group of CM students is that they were balanced in all of the learning-style dimensions, indicating that they can operate and learn on both sides of the scale (Felder & Brent, 2005). Table 8 summarizes the minority average CM learning styles on the ILS scale.

Table 8. Average CM Learning Styles of the Minority CM Population.

LSD1	VISUAL								X					VERBAL
Entry Channel		11	9	7	5	3	1	1	3	5	7	9	11	
							<-	->						
									X					
LSD2 Processing	ACTIVE	11	9	7	5	3	1	1	3	5	7	9	11	REFLECTIVE
							<-	->						
									X					
LSD3 Perception	SENSING	11	9	7	5	3	1	1	3	5	7	9	11	INTUITIVE
							<-	->						
									X					
LSD4 Understanding	SEQUENTIAL	11	9	7	5	3	1	1	3	5	7	9	11	GLOBAL
							<-	->						
		Strong		Mod		Balance		Balance		Mod		Strong		

This indicates, according to Felder & Silverman (1988) and Franzoni & Assar

(2009), that the average minority CM student remembers more from what they have seen (images, diagrams, plans, etc.) than what they have heard, read, or said (LSD1–Entry Channel). They learn by working together in groups and handling the materials better than working alone to think and reflect on the materials (LSD2–Processing). They would rather engage with facts and raw data for real world solutions, than with principles and theories. They are patient with details and want complicated ideas and processes broken down into smaller steps (LSD3–Perception). They follow a linear reasoning process when solving problems. They can work with information once they partially understand it. They are balanced in this learning style and can think globally and grasp the big picture of the information (LSD4–Understanding) (Felder & Silverman, 1988; Franzoni & Assar, 2009).

Discussion and conclusions

Because CM students are on average more visual, active, sensing, and sequential learners, this impacts many things in CM training methodologies. For the CM student, learning- style awareness could provide more ideas and tools to perform better academically. It can offer insight as to why students may be struggling in a course where the instructor is using a teaching style that does not align with their learning style. This metacognition, the awareness of how one learns, makes them more aware and holds them accountable for their educational experience. Critical thinking about one's own learning style is the first step toward becoming a lifelong learner. Felder and Brent (2005) agree that it's useful for students to know their learning styles. It provides them with more information about their learning strengths and weaknesses and how they can improve academically. Felder and, Brent (2005) also caution students (and instructors) that learning styles research has not shown any link in determining student capabilities. They should not be used to determine curriculum or career choices. As students become better learners, academic performance improves; thus, student satisfaction with their educational experience may improve. This could reduce dropout rates due to poor academic performance. Students may learn more and more deeply, graduating with a larger body of knowledge, giving them a better education investment for their money. They may be better prepared to enter the CM industry, where they will continue to learn and grow as the industry changes and grows (Felder & Brent, 2005).

A recommendation for instructors is to utilize ILS in the classroom to identify the differences that may exist in the current student body, and between research and specific classroom/course settings. The impact of knowing CM student learning styles means the CM instructor can be a more effective teacher. It begins with instructor re-evaluations of course syllabi and lesson plans to align teaching style with student learning styles. The students may be more engaged in the classroom, with the material, and with the instructor. They may experience a deeper learning of the material, so more material can be covered. The students may perceive a better educational experience, which can lead to better teacher evaluations. Rising job satisfaction for the instructors can be a byproduct of aligning teaching styles with the learning styles of the students.

By knowing their CM students' learning styles, and aligning their curriculum and course planning to those learning styles, CM programs and CM education more broadly may be impacted and improved. This goes back to the analogy of a company doing extensive market research on clients to better tailor services and business model to meet the client's needs. As CM programs align their courses and curriculum to meet the learning styles of their students, their instructors may do a better job of teaching, students' academic performance may improve, and they will perform better on their learning outcomes assessment, as required for ACCE, ABET, or ATMAE accreditation.

The impact of aligning the teaching style of CM programs and instructors with the learning styles of CM students is that programs may 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 on-the-job training, with an understanding of how they learn. They will enter the industry as lifelong learners. The impact of learning-style awareness doesn't end with graduation. It is just as important for industry trainers to know their new hire's learning styles and align industry training teaching styles to match.

As the CM industry changes, CM programs may continue to change to meet industry needs. At accreditation, program, and curriculum learning outcomes levels, the requirements of CM students may continue to be set by administrative and curriculum planners to meet the needs of industry. The real change will happen at the course development and delivery level. In light of CM learning styles, course development, learning activities, course delivery, and course assessment will most impact the needed changes in CM education. This means that the real burden of change falls on the shoulders of CM instructors. As important as it is for program administrators and students to recognize and know their learning styles, it is up to the instructors to make changes within the classroom. They are the change agents and the classroom is where the learning begins. Instructors have the most contact and influence with students. They are the ones who can influence students to take the ILS and discuss what the learning-style dimension preferences mean to the student and their future learning experiences. In most cases, it is the instructor who develops the course to meet the program's learning outcomes. Instructors create the learning activities, deliver the course, and administer assessment tools to students. Instructors may need to re-evaluate their course planning and ask themselves: Do my teaching style, learning activities, course delivery, and assessment methods align with the learning styles of the students? This is the first step towards a change that needs to happen.

While many instructors believe there would be a mix of students' learning styles in their classrooms, and that their teaching style needs to be balanced for all the students (teaching around the styles (Kolb, 1981)), this study shows that this is not the case for CM students. This study determined that 79% of CM students were visual, active, sensing, and sequential learners, while 21% were verbal, reflective, intuitive, and global learners. This means that in a classroom of 20, 16 of the students would be in on the left side (majority) of the ILS scale, and four students would be on the right (minority) of the ILS scale. This study is not suggesting that the instructor ignore the minority of learners in the classroom, rather, the instructor tailor their teaching style to the majority of the classroom and be mindful of the minority. This study has shown that the minority is balanced in their learning style preference and can learn on both sides of the ILS scale.

The instructor always has to adjust teaching style for the class size. Larger classes are inherently more difficult to keep students involved. If the class is too large to have a lab component, it is harder to provide and manage hands-on activities. A larger class will have more diverse learning styles of students. If the class is all CM students, then there will be a majority of visual, active, sensing, and sequential learners. If the class is a mix of AEC or other majors, the learning styles will be a mix as diverse as the majors, and the instructor will need to diversify teaching styles to match the student population.

A good place to start for instructors who want to align their teaching styles with student learning styles is the research done by Franzoni and Assar (2009). They made recommendations for different teaching style methods to align with different learning styles of students (Franzoni & Assar, 2009). For CM instructors, the first step is to evaluate the course planning (syllabus and lesson plans) and learning activities, the course delivery methods, and the course assessment tools. Do they align with the learning styles of a visual, active, sensing, and sequential learning CM student?

For the LSD1–Entry Channel (visual vs. verbal) learning style dimension, this study determined that 93% of the CM students strongly prefer a visual entry channel to a verbal entry channel, essentially meaning that in a classroom of 20, 19 of the students would be visual learners. The teaching style that should be adapted specifically for the visual learner CM student is the use of games, simulations, and highly visual presentations of the subject matter (Franzoni & Assar, 2009). An example would be to include the use of construction site pictures or live video feeds in the classroom, or the use of 3D building models to teach structural or building codes to the students.

For the LSD2–Processing (active vs. reflective) learning style dimension, this study determined that 72% of CM student participants were active learners, meaning in a class of 20, 15 of the students would be active learners. The teaching style best suited to the active-learner CM students focuses on course activities with hands-on labs, project simulation scenarios, and role playing (bid day, estimating, scheduling). CM student competitions that challenge students to participate in real-world scenarios in a teamwork and competitive setting are also highly beneficial for CM students (Bigelow, Glick, & Aragon, 2013).

For the LSD3–Perception (sensing vs. intuitive) learning style dimension, this study determined that 82% of CM students are sensing in their perception of the information, meaning that in a class of 20, 17 students would be sensing learners. The teaching style that should be adapted for the sensing learner CM students are course activities that build upon previously learned steps, and practiced like it is done in industry. An example is teaching CM students the foundational steps of planning a construction project schedule on paper before learning how to use scheduling software. Another example is teaching CM students to do a quantity take off (QTO) for large and easily quantifiable materials (concrete, steel, wood studs), followed by a more detailed QTO of harder-to-find objects, while adding material and labor costs to the estimates.

For LSD4–Understanding (sequential vs. global), 66% of the CM students are sequential thinkers vs. global thinkers, meaning that in a class of 20, 14 students would be sequential thinkers. Specifically for CM student education, showing students specific steps for how a building is constructed appeals to the sequential learner. However, CM students must also see and understand the global picture of the finished project. This is why LSD4– Understanding was the most balanced learning style dimension for CM students out of all the learning style dimensions.

CM instructors wanting to select appropriate course planning assessments and learning activities to address the majority learning styles of CM students identified in this research should incorporate highly visual elements. It can be a challenge to take verbal/written information (specifications, building codes, or construction law) and transform it into highly visually elements in the form of pictures, diagrams, or videos. The learning activities need to incorporate active, hands-on, and group-work elements. Students also need real-world construction examples, presented in facts and figure form. If the material/ project is complicated, it needs to be broken into step-by-step procedures CM students can follow. These steps need to follow the logical flow of how a construction project develops to tie the sequential steps together for the finished project.

Whether the course is offered as a traditional classroom format, online course format, or a blended course format that leverages the technology and pros of both traditional and online, the course delivery method utilized inside the course format should align with the CM students' learning styles. The presentation and class activities need to incorporate highly visual items. Pictures, diagrams, blueprints, and live video feeds are examples of highly visual elements that visual CM students' prefer and will remember. To enhance the visual elements and learning, active engagement with the students needs to be incorporated into the course delivery. Use of the question and answer method, iClickers, group projects, and hands-on labs are examples of active course delivery methods. Providing lecture notes and pictures ahead of time for class gives the students an active, visual element to work with during the presentation. Showing real world examples and breaking down the complex projects into logical step-by-step procedures, leading to the global picture addresses the sensing and sequential CM learning style in the course delivery.

An instructor may spend all term delivering highly visual and active course material and learning activities, yet the students' knowledge, retention, and learning is measured by a highly verbal learning style preference assessment tool. This may be a reason why a student can do well in class activities and then fail quizzes and exams. Course assessment tools should be aligned with learning styles of the CM students. The traditional tools of written quizzes and exams need to be transformed into visual element assessment tools. Group activities with final projects work well for the CM active learner. Whatever form the assessment tool takes, it should follow the step-by-step procedures and the learning activities. Each question needs to build upon the previous questions logically. Table 9 summarizes the changes that CM instructors could implement to make their course planning/learning activities, course delivery, and course assessment more relevant, based on the CM student learning style dimensions.

Table 9. Changes to CM course planning, delivery, and assessment.

	LSD1 Entry Channel: Visual	LSD2 Processing: Active	LSD3 Perception: Sensing	LSD4 Understanding: Sequential
LSD Defined (Felder & Silverman, 1988; Franzoni & Assar, 2009).	Remembers what they see; images, diagrams, time tables, films, etc. They would rather work with visual representations when receiving information.	Comprehends and assimilates new information when they practice using it (discussion, implementation, group presentations) and rather learn working with others.	Specific, facts and procedure oriented. They're patient with details, but don't like complications. They enjoy lab classes and problem solving by following well-established procedures. They want courses to connect to the real world.	Follows a linear reasoning process when solving problems. They can work with a specific material once they've comprehended it partially or superficially. They learn through small orderly steps when these are logically associated.
Associated Teaching Style (Franzoni & Assar, 2009)	Presentations with highly visual elements. Games and simulations	Learning based on problem solving. Role playing, discussion panel, brainstorming, project design method, games and simulations.	Learning based on problem solving. Presentation with question and answer method.	Presentation with question and answer method.
CM Course Planning /Learning Activities. Evaluate course syllabus and lesson plan to incorporate:	Highly visual elements. Take verbal elements and convert to visual elements via 3D modeling, you tube, pictures, or videos.	Active learning elements. Group projects and hands-on learning activities.	Real world examples. Present facts, figures, and procedures. Incorporate Lab activities when possible.	Step-by-step logical material of the global big picture. Show how the steps of construction finish with a complete building.
CM Course Delivery	Highly visual elements. Pictures, diagrams, videos, blueprints. Live video feed into classroom (Shaurette, 2007).	Active. Engagement in classroom. Use of iClickers (Bartsch & Murphy, 2011) . Group projects, hands-on work, labs. Project design method.	Learning based on problem solving. Q&A method. Break complicated material into smaller sections. Show how it applies to the real world.	Break material down and show content in steps. Show how material steps are connected logically.
CM Course Assessment	Take written /verbal element assessment tools and transform them into visual element assessment tools.	Make assessment an active, group activity/final project.	Assessment needs to follow same procedures as the learning activities.	Assessments follow the logical step of the materials. Questions should build off of each other as the material was presented, step-by-step.

Future Research

This study generates many questions for future research. Once CM instructors know their students' learning styles, does changing their teaching style to match student-learning style improve student performance? How would teaching style be measured? Is there a correlation between instructor learning style and student learning style?

As CM courses are reevaluated and changed to align with CM student learning styles, instructors need to document the changes, including what worked and what did not, and how effective the changes were.

Several questions remain: What is the significance of the levels of learning styles (balanced, medium, and strong) of the CM students? Do the student demographics of this study represent the demographics of American CM students? Do CM learning styles differ between schools and/or programs? What are the learning styles of CM graduate students, and do they differ from undergraduate students? What are the learning styles of architecture, interior design, and engineering students based on the ILS?

For future research on the effects of ethnicity, culture, and learning style, a more ethnically diverse population is required and data collection need assess student country of origin and education.

Do learning styles change as students mature across their undergraduate years? Do student-learning styles change over time? A longitudinal study tracking students and their learning styles through their college careers would be needed. CM industries and associations could fund long-term studies and provide incentives for more students to participate in future research on learning styles.

References

Abdelhamid, T. S. (2003). Evaluation of teacher-student learning style disparity in construction management education. *Journal of Construction Education*, *8*(3), 124–145.

Andersen, N. J., & Andersen, K. W. (1998). Performance outcomes: An integral component of program assessment. *Journal of Construction Education*, *3*(2), 164–172.

Andreou, C., Papastavrou, E., & Merkouris, A. (2013). Learning styles and critical thinking relation- ship in baccalaureate nursing education: A systematic review. *Nurse Education Today*, *34*(3), 362–371.

Benhart, B. L., & Shaurette, M. (2011). *Establishing new graduate competencies: Ensuring that construction management curriculums are delivering* "*job-ready*" *employees*. Paper presented at the 47th ASC Annual International Conference Proceedings, University of Nebraska-Lincoln, Omaha, NE; April 6-9, 2011.

Bernold, L. E. (2005). Paradigm shift in construction education is vital for the future of our profession. *Journal of Construction Engineering and Management*, *131*(5), 533–539.

Bernold, L. E. (2007). Teaching evaluations for construction engineering and management: Opportunity to move us forward. *Journal of Construction Engineering and Management*, *133*(2), 146–156.

Bernold, L. E., Bingham, W. L., McDonald, P. H., & Attia, T. M. (2000). Impact of holistic and learning-oriented teaching on academic success. *Journal of Engineering Education*, *89*(2), 191–199+247-248+251.

Bigelow, B. F., Glick, S., & Aragon, A. (2013). Participation in construction management student competitions: Perceived positive and negative effects. *International Journal of Construction Education and Research*, *9*(4), 272–287. doi:10.1080/15578771.2013.809037

Broberg, Lin, P., & Griggs, K. (2008). Learning styles of engineering technology and engineering students: Pedagogical implications. *Journal of Engineering Technology*, *25*(1), 10–17.

Chunduri, S., Zhu, Y., & Bayraktar, M. (2011). Improving green building education by addressing the learning style and prior knowledge of students. *Journal of Professional Issues in Engineering Education and Practice*, *137*(4), 232–238. doi:10.1061/(ASCE)EI.1943-5541.0000063

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). Learning styles and pedagogy in *Post-16 learning: A systematic and critical review*. London: Learning & Skills Research Centre.

Felder, R. M. (1993). Reaching the second tier: Learning and teaching styles in college science education. *Journal of College Science Teaching*, *23*(5), 286–290.

Felder, R. M. (1996). Matter of stye. *ASEE Prism*, *6*(4), 18–23.

Felder, R. M., & Brent, R. (2005). Understanding student differences. *Journal of Engineering Education*, *94*(1), 57–72.

Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Journal of Engineering Education*, *78*(7), 674–681.

Felder, R. M., & Spurlin, J. (2005). Applications, reliability and validity of the index of learning styles. *International Journal of Engineering Education*, *21*(1), 103–112.

Fellows, R. F., & Liu, A. M. (2009). *Research methods for construction*: John Wiley & Sons.

Franzoni, A. L., & Assar, S. (2009). Student learning styles adaptation method based on teaching strategies and electronic media. *Journal of Educational Technology & Society*, *12*(4), 15–29.

Harfield, T., Panko, M., Davies, K., & Kenley, R. (2007). Toward a learning-styles profile of construction students: Results from New Zealand. *International Journal of Construction Education and Research*, *3*, 143–158.

Kolb. (1981). Learning styles and disciplinary differences. *The modern American college*, 232–255. Kolb. (1984). *Experiential learning: Experience as the source of learning and development*: Upper Saddle River, NJ: Prentice Hall.

Kolb, A. Y., Boyatzis, R. E., & Mainemelis, C. (2001). Experiential learning theory: Previous research and new directions. *Perspectives on Thinking, Learning, and Cognitive Styles*, *1*, 227–247.

Litzinger, T. A., Lee, S. H., Wise, J. C., & Felder, R. M. (2007). A psychometric study of the Index of Learning Styles. *Journal of Engineering Education*, *96*(4), 309–319.

Zywno, M. S. (2003). *A Contribution to Validation of Score Meaning for Felder-Soloman's Index of Learning Styles*. Paper presented at the 2003 American Society for Engineering Education Annual Conference & Exposition, Nashville, Tennessee; June 22-25, 2003.

Appendix A

Associated Schools of Construction (ASC) Participating Schools.

Region 1 – Northeast	85	**Region 5 - South Central**	111
Central Connecticut State University	5	Louisiana State University	30
Norwich University	31	Texas A&M University	81
Pennsylvania College of Technology	25		
SUNY Delhi	16	**Region 6 - Rocky Mountain**	147
Temple University	4	Brigham Young University	80
University of Massachusetts - Amherst	4	Colorado State University	33
		Northern Arizona University	12
Region 2 - Southeast	199	Utah Valley University	12
Georgia Institute of Technology	4	Weber State	10
Kennesaw State University	2		
Southern Polytechnic State University	20	**Region 7 - West Coast**	54
Virginia Polytechnic University	173	Cal Poly San Luis Obispo	12
		California Baptist University	5
Region 3 - Great Lakes	222	New School of Architecture	9
Michigan State University	25	Washington State University	16
Northern Kentucky University	7	California State University	12
Northern Michigan University	6		
Purdue University	138	Total Schools	36
University of Cincinnati	24	Total Participants	1100
University of Wisconsin - Stout	16		
Western Illinois University	6		
Region 4 - North Central	282		
Minnesota State University - Mankato	48		
Pittsburg State University	60		
South Dakota State University	20		
Missouri State University	79		
Southeast Missouri State University	29		
University of Nebraska - Kearney	34		
University of Northern Iowa	12		