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Using Mentors as Live Case Studies for Teaching Topics in Supply Chain Management

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Introduction:

At The Ohio State University and many other universities across the country, the case study approach is used to teach students the intricacies of business practices and the help them understand the tradeoffs between different organizational goals in Supply Chain Management. In the Integrated Systems Engineering department, the undergraduate students take rigorous courses in linear and non-linear programming as well as simulation modeling as part of their operations research core classes. In their junior year, they take a class where many of these methods can be applied called Production Planning and Facility Layout. It is this course that is the subject of the research described in this paper.

Today's industrial systems engineering students do not just go into the traditional manufacturing sector, but also delve into many diverse fields such as healthcare, the airline industry, humanitarian logistics, and complex Internet based e-commerce distribution channel roles. In an attempt to enhance student learning, the course was developed with what is being called the "Live Case Study" approach. Rather than just having students read and report on pre-written cases, they were divided into groups of four students, and each team was assigned a unique mentor from industry who works in a supply chain role to help them understand the class materials through applications to the mentor's business model. Previous epistemological/meta cognition research has inferred that if students understand a framework for their knowledge, this will improve learning outcomes and knowledge retention. B.K. Hofer reported in 2004, "Beliefs are situated in a socio-cultural context and we need to know more about contextual influences, instructional practices, and how students interpret them epistemologically as they acculturate to new educational settings." [1]

Drawing on my 30 years of engineering practice in industry, I realized that much of the material covered in this class was used daily in most corporations even if they didn't use it exactly like it was taught in the textbook, they used the principles. It seemed evident that if students understood the importance and could learn from professionals using these methods, they would understand the concepts better. Additionally, with this experience in industry and occasional recruiting to support my own organizations hiring needs, I realized that corporations want to be involved with undergraduate engineering students to help increase their visibility on campus. Further, many alumni want to get involved with their institutions as a way of staying involved with the university and giving back by "Paying it forward," as espoused by our former football coach, Woody Hayes.

Impetus for this work:

The purpose of this research is to gather a preliminary understanding of the effectiveness of a teaching method using the 'live case study' approach as it is being called for the purposes of this

paper. The 'live case study' approach is a method of reinforcing concepts by having students, grouped together in four person teams, interact with an industry Supply Chain professional on regular conference calls and finding out how the professional uses the specific method being covered in class. Essentially, they are asking, "How do you do this at General Motors?" as an example. After each of the five conference calls, the student group writes a reflective paper about what they have learned. This method differs from the traditional case study approach because the students do not just read what is written, but can ask initial questions and ask follow-up questions to get a better understanding of what is important by the inflection of the mentor's voice and hearing the mentor convey it in his/her own words.

This research is for the purpose of sharing best practice with other instructors and understanding the key factors to the program's success. With this preliminary understanding, it is possible to determine if an additional longitudinal study could be used to determine if this teaching approach brings skills to students to help them perform in their capstone projects more effectively. Specifically, the goal is to determine if this teaching method increases student conceptual understanding of the material and interdependencies between different aspects of the course

The ideation for this research falls at the intersection of traditional education concepts, specific research on the education of business end of systems management, and future goals for engineering education.

Beginning with traditional education processes, in 1973, curriculum theoretician, Joseph Schwab, wrote The Practical: A Language for Curriculum, where he described the four commonplaces of learning as the learner, the instructor, the content, and the milieu.[2] The milieu is the learning environment that covers social and physical setting in which learning occurs; it includes the backdrop, atmosphere, and context. By connecting the students' learning with a network of people working in their possible future career fields, we hypothesize that the students' focus on learning will increase because they can relate to possible future positions they may hold and they have someone else supporting their learning.

Harvard Business School as well as other universities have used the case study approach to teach business/systems management. They regularly use this method to provide a deeper message regarding the subject at hand. Two common features of the case study method are a holistic approach to understanding the situation and a broader social context of the motivations those involved. "Because of its strengths, the case study is a particularly appealing design for applied fields of study such as education, social work, administration, health, and so on. An applied field's processes, problems, and programs can be examined to bring about understanding that in turn can affect and perhaps even improve practice."[3] With this course being an applied course, it lends itself to understanding practices in management would logically be a good course to apply this methodology.

The third branch of triangular intersection is aligned where traditional engineering education has begun promoting a strong culture of Active Cooperative Learning (ACL). ABET, the Accreditation Board of Engineering and Technology, has recommended this pedagogical approach as a method because focusing students on real-world problems can increase their motivation.[4] By using the live case study approach in this class, the traditional student group,

expanded to include the mentor, can work together to synthesize their understanding of the application, through the question and answer process. The students can reinforce the concepts with each other through the process of writing reflective papers on how their mentor company applies the techniques. Finally, the objective of this method is pulled together by the National Academy of Engineering report, Educating the Engineer of 2020, which emphasizes that educating students to identify the complexities in "the knowledge, skills, and breadth of thinking necessary to perform in leadership roles in government, industry, and, more broadly, all aspects of society."[5] As students see their mentors exhibiting these skills of balancing various aspects in their problem solving, they gain not only technical expertise, but get a peep hole view into some of the broader systems thinking skills they will use in their capstone projects and later careers.

Finally, one reason to explore this method is that it may be an instructional method that could be used part of a process to educate the 20,000 Grand Challenges Engineers. In 2008, the National Academy of Engineering issued 14 Grand Challenges encompassing the broad range of human concern including sustainability, health, vulnerability, and the joy of living.[6] To impact these Grand Challenges, the NAE has identified a need to change the educational process for the engineers that will tackle these challenges and have challenged institutions of higher education to meet these goals. As of March 2015, the NAE have signed 122 engineering schools to a pledge to educate a total of 20,000 Grand Challenge Engineers over the next decade. According to their press release, "The Grand Challenge engineers will be trained through special programs at each institution that integrate five educational elements: (1) a hands-on research or design project connected to the Grand Challenges; (2) real-world, interdisciplinary experiential learning with clients and mentors; (3) entrepreneurship and innovation experience; (4) global and cross-cultural perspectives; and (5) service-learning. "Teaching engineering fundamentals in the classroom is important, but it's not enough," said Richard Miller of Olin College. "Solving our planet's Grand Challenges requires engineering expertise, but they won't be solved by engineers alone. Doubling down on even more hard sciences and math will not help. Instead, we need to incorporate new elements into engineering students' education to give them both the skillset and the mindset needed to become leaders in addressing societal challenges."[7] If the research proves this method effective, then using programs like this as a mechanism to support the Grand Challenges by helping students connect the dots between their education, the application of those concepts in business, the impact of globalization, and importance of sustainable systems, is one way to support these goals.

The Course Structure

To better define the purpose of this research, the diagram below describes theoretical framework for this methodology.

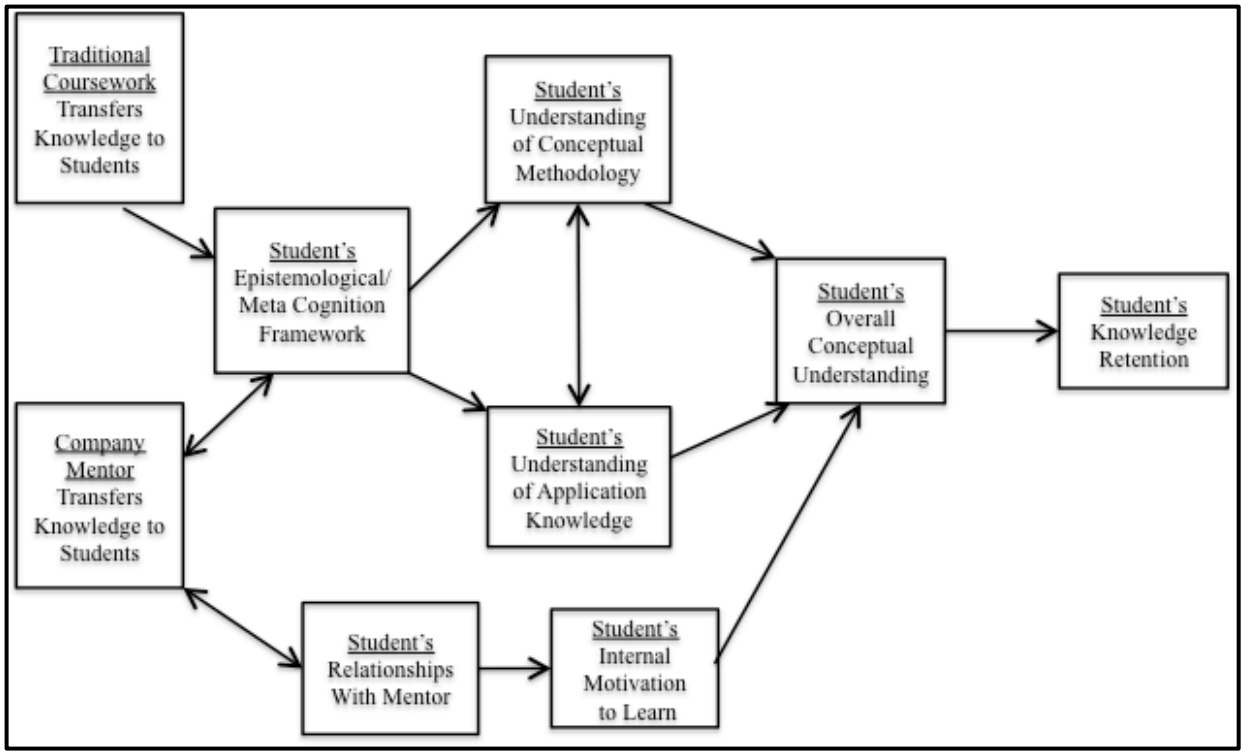

Figure 1: Theoretical Framework for Research

Prior to beginning the course, the instructor solicited members of the professional community involved in supply chain in some form to become mentors for this course. The 15 mentors came from a range of positions, roles, and locations and they all agreed to support this 60-student class with about 5 hours of their time throughout the semester by sharing their applications for the course material. Figure 2 illustrates some prominent characteristics of the mentors.

Figure 2: Prominent mentor characteristics corresponding to the number of mentors.

Mentor Characteristics	**# of mentors**
Mentors were business consultants working with multiple clients	2
Mentors were plant managers with a busy schedule	2
Mentors were high level execs, but had control of their daily schedule	2
Mentors were recent grads working in entry level manufacturing positions	2
Mentors were mid-level managers in supply chain organization	6
Mentor was in service organization tied to supply chain of a hospital, not in manufacturing business	1

Prior to the first day of class, each student was asked to provide a picture and short biography of themself and their work experience. Additionally, they were asked to complete a survey on teamwork software called CATME, Comprehensive Assessment of Team Member Effectiveness, which would identify some of their personal characteristics and also look at their schedule availability. On the first day of the course, the students were grouped using a random process with teamwork software CATME to diversify the groups

but also try to align students with the best schedule availability. Mentors were assigned to each group with the goal to ensure equal learning opportunities for all students in the group. To achieve equal access, no student was to have a previous relationship to the mentor's company through a previous or upcoming internship or other affiliation like parent or sibling employment

The course was broken down into 6 key segments over the 15-week semester as follows:

- Operations Management – Company Business Model including Products or Services, Operational Metrics, Lean Process Improvement Philosophy, Globalization components, Sustainability Goals
- Demand Forecasting
- Inventory Management
- Production Planning and Scheduling
- Logistics
- Facility Layout

The students were given a rubric for their assignments and in this was a set of instructions for the Mentored Group Activity Reports, which were to be written after each conference call with their mentor. Each topic area contained a description of the topic and a brief list of questions that were a starting point for the students to ask their mentors. The students were coached on how to interact professionally with their mentor and to send their mentor questions ahead of their calls so the mentor could be prepared for the conversation. Next, the students were asked to create a group biography, from those previously submitted and send this to their mentor to kick off the conversation. The diagram below provides an outline of the course structure to show how the class learning and reporting on application at the mentor's company intertwine.

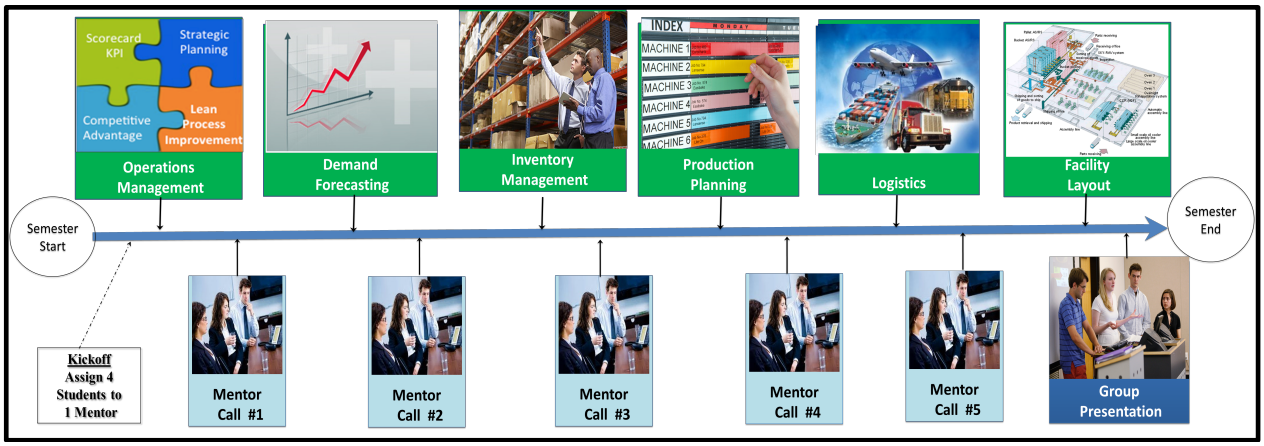

Figure 3: Course structural layout

The student groups worked with their mentor throughout the term, conferring with them after each major section. Students would schedule and conduct conference calls with their mentor to understand how the mentor's company applied the class knowledge to their business. Rather than using a traditional case study approach of just reading about an

application, the students had a **live** case study that they could learn through interactive questioning. By keeping this process active for the whole semester, they could form a relationship with their mentor, which would ideally enhance their learning as well. Furthermore, by keeping a consistent business in mind, the students would ideally develop a clearer frame of reference of how these concepts were applied in one organization. This would help the students understand the relationship between these course topics, which is critical in Supply Chain Management. All the elements affect the other element, so the student has to learn that they cannot consider these in isolation.

Each of the major subject of the semester follows a learning pattern that starts with introduction of the topic in the classroom followed by homework, but soon afterward, there is a conference call between the students and the mentor. After this call, the student team creates a 3-4 page summary of their mentors' application called a Mentor Group Activity Report (MGAR). The graphic below shows the pattern used for this class.

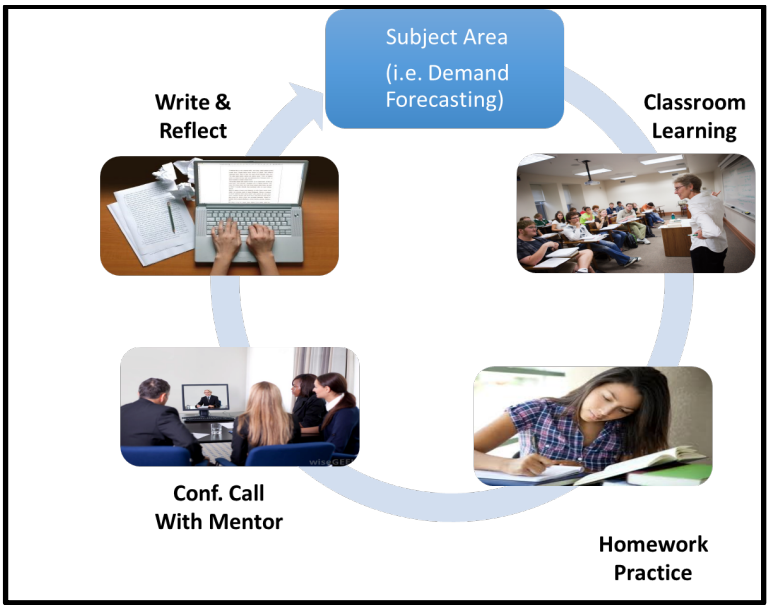

Figure 4: Cycle of Course Learning

Throughout the term, student groups were required to write 5 reflective papers on the topics above framing how their mentor's organization applied these tools to their business. The first paper focused on the overall company itself including business areas and products, overall company size, area of expertise and focus of the mentor. It also included information on the company's operational strategies and structure around globalization of the supply chain and their sustainability goals which are aligned with our ABET criteria. This first paper provided a frame of reference for subsequent papers by describing the overall company and understanding the mentor's focus. After each topic was covered in the course (2-3 weeks), the student groups would meet, normally over the phone, with their mentor to learn how the mentor's company applied that technique to their business and write

a paper on that topic. Each group member was required to take the lead on 1 reflective paper.

At the end of the semester, each group gave a 10 minute presentation to the class about their mentor's company and their application of course concepts. This allowed the students to share characteristics of their mentor's company to the other students in the class, giving them an opportunity to compare business models and applications. Mentor's were invited to participate in these presentations either by attending the class or connecting via videoconference. Approximately 65% of the mentors observed their students presentations in one manner or another.

Methods:

On the last day of class after the presentations, the students were asked to participate in a voluntary survey, which contained specific consent language allowing this survey to be used for research purposes outlined in the IRB. No incentives were given to students taking this survey. The survey results were independently collected and stored until after grades were submitted. Data had no identifying information. Once the data was transferred to tables, the original documentation was destroyed.

Research questions were framed around a qualitative analysis approach to gather student reactions to the live case study method and effectiveness of this approach on their learning.

The first 3 questions of the survey were quantitative data to gauge their experience:

- How many semesters until you expect to graduate? Answers selectable were from 0 (Graduating this semester) to 4 semesters until graduation.
- How many terms have you had a previous internship? Answers selectable were from 0 to 4.
- How many terms have you had an internship in a supply chain organization? Answers selectable were from 0 to 4.

The next 5 questions were qualitative to gauge their perceptions of this experience:

- List up to 5 benefits you took away from working with your mentor.
- Which concepts were the most cemented in your mind by your mentor?
- List up to 5 drawbacks of using the mentoring approach in this course.
- What surprised you in the process of working with your mentor?
- What recommendations do you have for improving the Live Case study approach?

To analyze this data, all responses were reviewed by 2 people. One person was the instructor of the course and primary researcher. The other reviewer was a graduate student in biomedical engineering who has worked frequently with others in the engineering education organization. As the reviewers looked at each question, they developed a set of common themes which were coded into a set of 5-7 identifiers for each question. Both reviewers independently read through the qualitative responses and analyzed the responses for each question against the pre-coded identifiers. After this review, the reviewers

compared their analysis. The reviewers talked through the small percentage of items that were different and came to a consensus on the response coding for each item.

Analysis and Results

Participants

Fifty-one students (of 60 students in the class) provided survey responses for this questionnaire. Most of the students were junior level with 1-2 semesters of additional coursework before graduation. Approximately 1/3 of the students had experienced at least 1 internship and over half of the students had worked some where in supply chain during a previous internship.

Figure 5: Distribution of Student Academic Experience
Semesters expected until graduation

Semesters until Graduation	# of Students	%
0	1	2.0%
1	23	45%
2	18	35%
3	9	18%

Figure 6: Distribution of Student Internship Experience
Terms of Previous Internship Experience

Terms of Internship Experience	# of Students	%
0	4	8%
1	13	25%
2	16	31%
3	13	25%
4	5	10%

Figure 7: Distribution of Student Internships in Supply Chain
Terms of Previous Internships in Supply Chain

Terms of Internship Experience	# of Students	%
0	33	65%
1	10	20%
2	5	10%
3	3	6%
4	0	0%

Benefits of Working with Mentor

The first qualitative question, question 5, asked to gather experiential data regarding the mentoring process was: List up to 5 benefits you took away from working with your mentor.

The 51 students reported a total of 148 different responses covering a variety of benefits they gained from working with the mentors. The most prominent responses were based on the "Real World" identifier, allowing them to see how class concepts were applied in the 'real world', which aligned with the purpose of the teaching method. The students clearly enjoyed the opportunity to learn the material in a different format than traditional classroom methods. Additionally, students gained skills in networking with professionals and understanding more about their potential future careers. Furthermore, they gained professional and teamwork skills that they thought would benefit them in their later roles. Notably, a few responses indicated that live case study process was enjoyable. One response stated, "Seeing real world examples vs. book problems plays a big role in learning the material."

The graph below shows the distribution of the 148 students' responses.

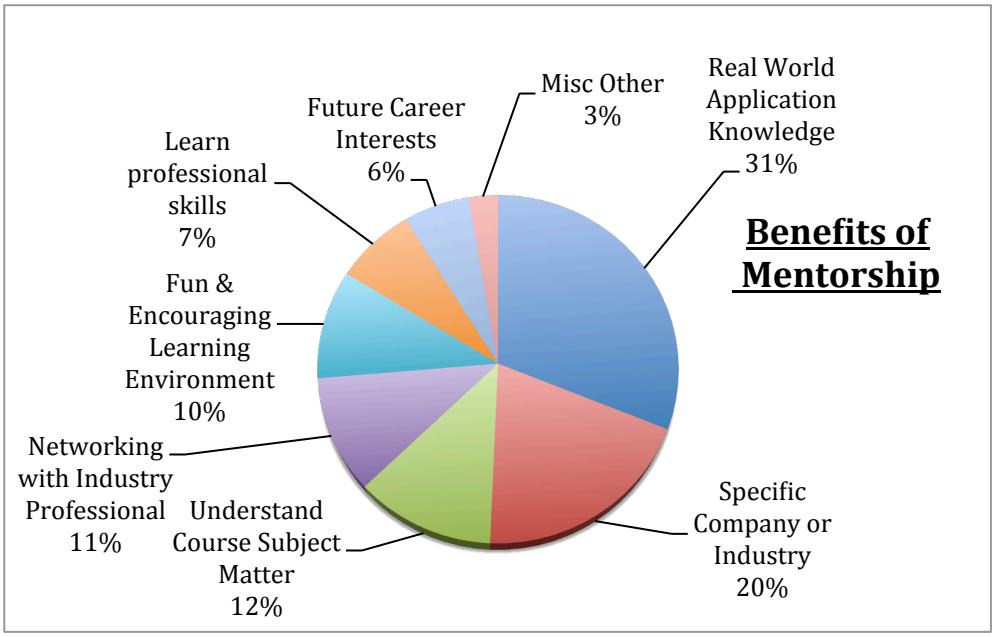

Figure 8: Benefits of Using Mentoring Approach

Concepts most cemented through mentor interaction

The sixth question: Which concepts were the most cemented in your mind by your mentor? was important because it identified a significant result. Students submitted a total of 79 responses to this question. Importantly, 84% of the responses indicated that the students understood some subject of the course better because of their discussion with their mentors. Most answers were related to the main subject matter topics of the class like demand forecasting, facility layout, and inventory management. Those items were grouped into one area called subject matter, showing that the majority of what was cemented in their mind was related to the key objectives of the course.

Additionally, students gained insight into other important business factors through interaction with their mentors. The students reported gaining a better understanding of how company's work and the impact of company culture on organization effectiveness. One of the goals of the course was to help the students understand that the goals of a supply chain cannot be optimized in isolation from other goals. One of the students that understood this said, "It's always important to look at the whole picture. Most problems can't be isolated. They have to be considered along-side the other factors in the system as a whole."

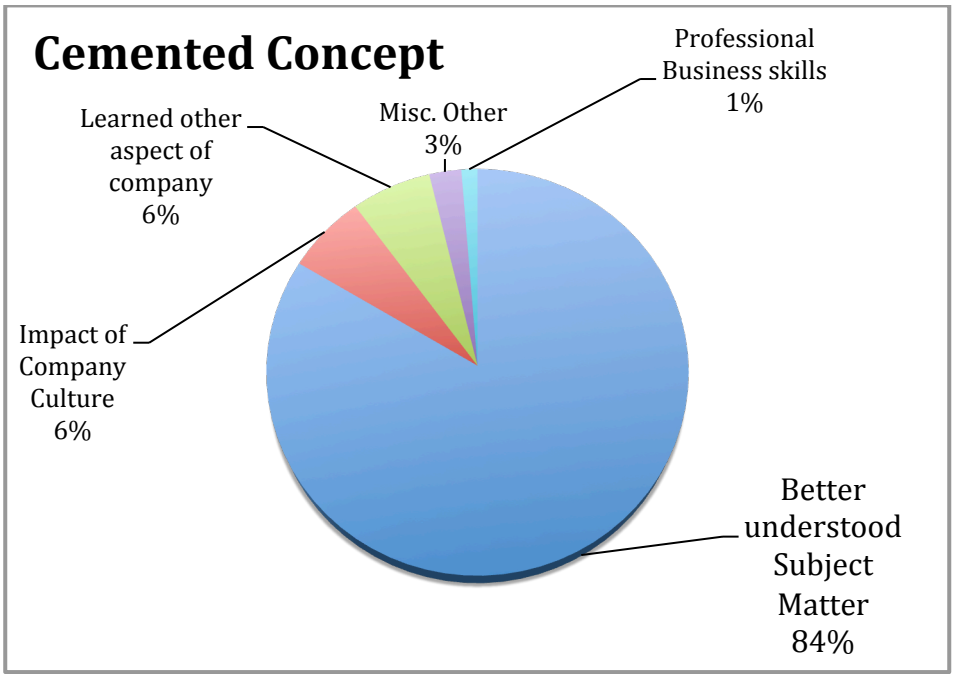

Figure 9: Concepts most Cemented

Drawbacks of working with mentors

Question seven asked: List up to 5 drawbacks of using the mentoring approach in this course. There were 98 drawbacks of working with mentors identified for this question. The drawbacks were centered on 2 key issues. One issue was trying to schedule conference calls between 5 independent and busy people. This problem was clearly exacerbated by a couple of mentors that had high level roles such as plant directors and whose schedule would be constantly changing. Another issue was that some mentors were not ideally suited for this role; due either to their lack of interest, or their position was not directly in the supply chain area. This caused a problem of un-equal opportunities between some students who had a great opportunity and others who did not. Many students mentioned this un-equal opportunity even if they were ones that had a good experience, knowing that some of their some classmates were disappointed.

One student had a particular negative experience with their mentor and said, "Mentor wasn't very involved/ didn't have time for us."

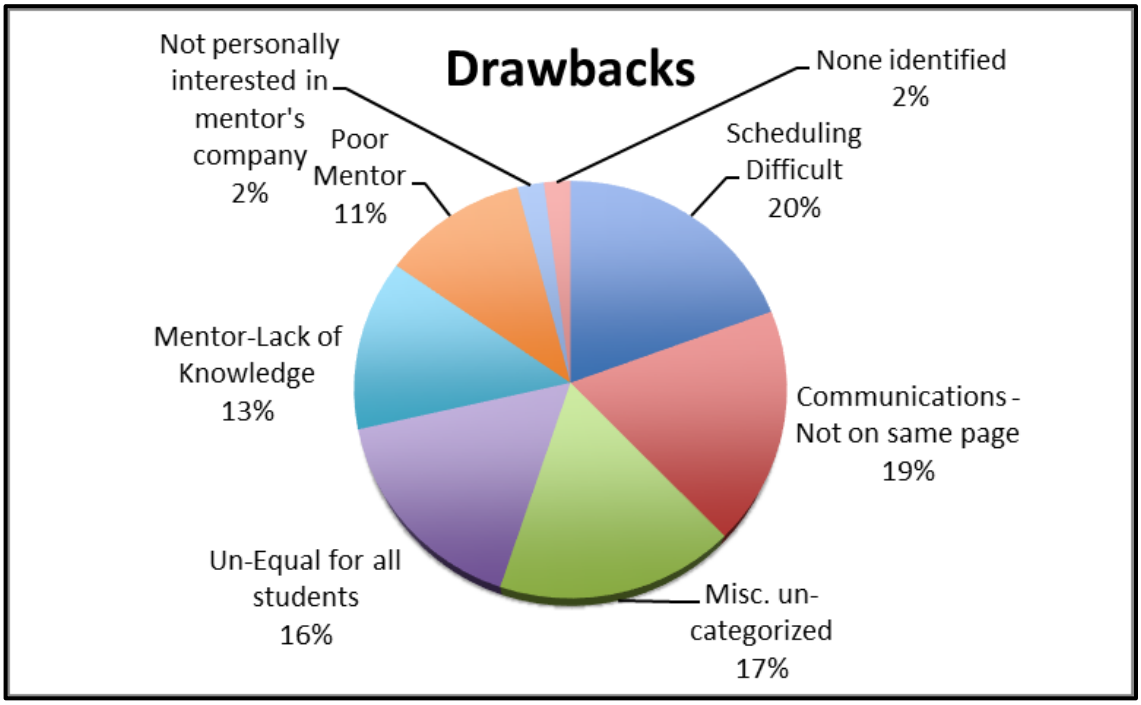

Figure 10: Drawbacks of Working with Mentors

S*urprises in working with mentor*

The eighth question was: What surprised you in the process of working with your mentor? There were 53 responses provided by the 51 students to this question. Clearly, the majority of the students were pleasantly surprised that their mentor was engaged, positive, and wanted to pass along their experience as a way of contributing to their learning. Also, students were surprised by how much experience their mentor's had in the area of the subject matter and the application of course material. Many students thought that the process enhanced the learning process. Some students indicated mentors who weren't supportive, which took away from their experience and learning.

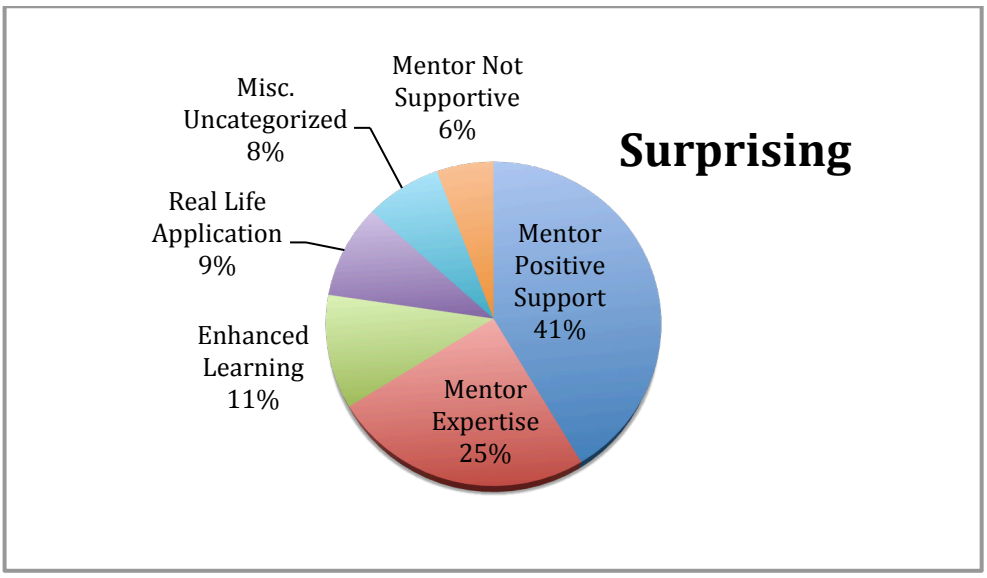

Figure 11: Surprising Outcomes of working with mentor

Recommendation for improvements

The final question: What recommendations do you have for improving the Live Case study approach? Three clear themes emerged from the recommendations process. One recommendation had to do with the assignments themselves – both the reports and the final presentation. For the reports, the students requested more flexibility to adapt the structure to meet their mentor's company. For the final presentation, many students suggested changing the goal from communicating about a change the company should make, to communicating the key takeaways they learned from the experience and particularly how their mentor company applied the concepts in their unique organization. This could include both strengths and challenges they had in applying these methods. Another recommendation was to increase the oversight provided by the instructor. This might include helping students with their problematic mentor relationships and steering things in a better direction if they go off course. To support this, one response stated, "more of a 'coaching atmosphere' instead of having students leading everything." This recommendation could be facilitated by a periodic check in with student groups rather than expecting to hear about problems without specifically requiring feedback.

The final recommendation was regarding face-to-face time with their mentors. Some student groups took it upon themselves to go visit their mentor, even though this was not formally required. This meeting and usually facility tour strengthened their relationship with their mentor, improved the students' understanding of the business, and improved their final presentation. Some groups could not do this due to the distance to their mentor's site, and other groups didn't even consider traveling to visit their mentor as an option even though it wasn't too far. Many responses suggested either getting more local mentors to make this possible and/or facilitating the face-to-face process to the extent possible.

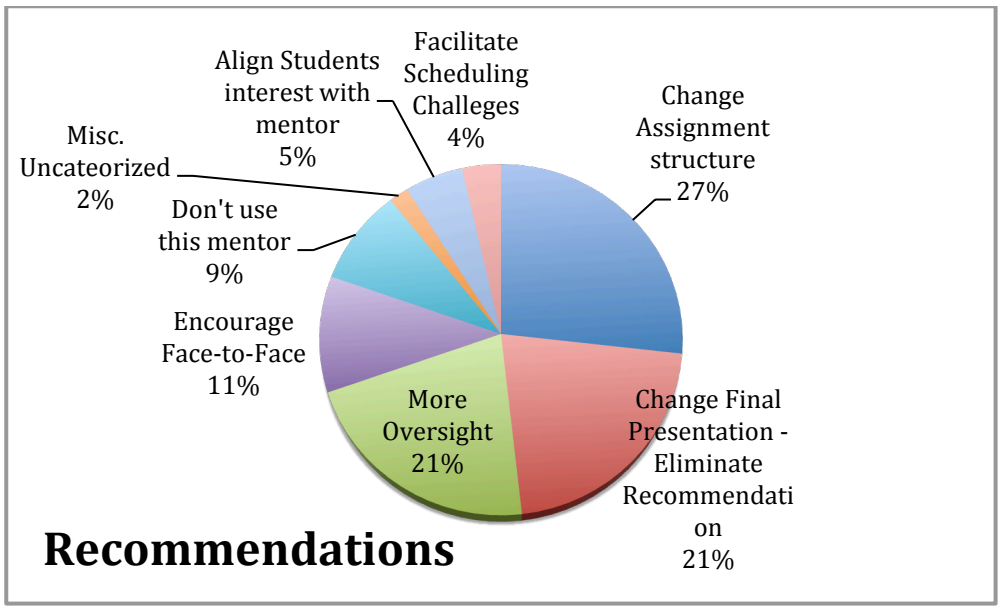

Figure 12: Recommendations for Improvement

Summary

Data from the first semester this course was taught using the live case study approach is very favorable. Survey question six: What was most cemented in your mind? had over 60 responses where a concept was strongly cemented in the student's mind. This is important because in today's fast paced and often distracted learning environment, it is difficult to cement ideas in the minds of students. Engaging with industry professionals is clearly a way to improve on this outcome. When the students know the material matters in their potential future career, they are more likely to hone in on it. Listening to someone who they have built a relationship with over many weeks can enhance this learning. Overall, the majority of the students in this course had a very favorable experience with their mentor and provided positive feedback. Their surveys indicated that they believed they had improved learning when compared with a traditional class that consists of reading, lectures, active learning in class, and textbook homework. The results show strong evidence that providing students with external mentors who regularly use and understand the processes taught in a supply chain management course can enhance student learning. One student stated, "Our mentor was very helpful in all areas so we almost had a second 'teacher' for the semester." It is often beneficial for students to learn from multiple people due to repetition and different perspectives. However, the process does have pitfalls, which must be managed and improved upon as they are discovered. Some of the pitfalls included unengaged mentors or unknowledgeable mentors who may not be familiar with the concepts being taught. However, with continued refinement, this teaching method can be used to enhance student learning.

Additional Research and Exploration

Further research is required to determine if this method will enhance student retention of knowledge, which was the long-term goal. Previous research suggests giving students a

framework for their knowledge should help them retain the knowledge. Some qualitative data might be understood in a couple of years by soliciting feedback from capstone instructors on changes they have seen in student performance

Even though this process was tied to a more business related supply chain management class, there might be an opportunity to use this method in other departments where students struggle to understand concepts that they are learning. One possibility is bringing in mentor engineers from automotive companies to go over problems with components, which experience fatigue failure, which could enhance mechanical engineering courses on machine design. Using mentors to review problems with electrical component overheating for example could enhance electric engineering courses. Using this approach, other engineering students could see real world applications of their course concepts presented by engineers practicing these methods. Students often have the misconception that they really don't have to thoroughly understand what they learn in school, because they will never have to do it again. Through these experiences, they may understand this is not true and they may learn better then they do without this practical context.

In addition to providing learning for students, working with mentors gives an opportunity to engage alumni and college industry partners. These relationships are valuable to forge lasting bonds that can lead to further opportunities for industry sponsored research or curriculum enhancement.

One part of the mentor-student mentee process that was not explored in this research was impact of the mentoring process on the mentors. Identifying what opportunities they see from this method is important. Specifically, there are questions about whether the methods taught in class are matched with current industry best practices. Also, what business savvy skills like teamwork, professional skills, and this process could enhance communication skills and how could we further develop those skills in the students. Mentors who are mid-level managers are often coaching their employees and may see opportunities to provide that support in this course as well.

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