Integrating the Entrepreneurial Mindset Throughout Higher Education: A Case Application for the Industrial Engineering Classroom

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1. Introduction

The entrepreneurial mindset is defined as the “inclination to discover, evaluate, and exploit opportunities” [1]. Developing the entrepreneurial mindset is not only important for individuals wanting to start their own businesses, but also for those wanting to add value creatively to the company they work for, or their personal life. Moreover, the entrepreneurial mindset is critical in solving complex social issues. Within higher education, educators across disciplines are increasingly focused on cultivating this entrepreneurial mindset in their students as a means to prepare them for the contemporary workforce and society. As such, entrepreneurial educators are an integral part of creating the next generation of start-up entrepreneurs, corporate innovators, and world changemakers. These entrepreneurial educators exist not only within business schools, but also throughout universities in areas such as engineering, food science, the liberal arts, and more.

Fortunately, there are many resources available to support effective entrepreneurial learning activities. Many of these resources can be obtained for free through online platforms including Stanford’s d.School website (https://dschool.stanford.edu/) and the Kern Entrepreneurial Engineering Network (KEEN) portal (https://engineeringunleashed.com/). Also, several books focus on teaching, including “Teaching Entrepreneurship: A Practice Based Approach [2],” “How to Teach Entrepreneurship [3]” and “Classroom Exercises for Entrepreneurship: A Cross-Disciplinary Approach [4]”. These resources provide many examples of entrepreneurial learning activities, yet, are limited in two ways. First, most of the learning activities are grounded within the business discipline, and second, they do not reflect a holistic design approach, whereby the instructor considers the entire learning process from curriculum development to delivery to assessment. Thus, instead of considering the learning experience from a holistic perspective, these resources tend to focus on isolated learning activities and/or learning assessment with limited regard for the course design and delivery as a whole.

The purpose of this paper is to apply a standardized, holistic approach for integrating the entrepreneurial mindset into existing courses across academic disciplines using the following four curriculum design components [1]:
• #1: Curriculum Design for Entrepreneurial Integration
• #2: Curriculum Design for Professional Skills
• #3: Curriculum Design for Habit Development
• #4: Curriculum Design for Best Teaching Practices

The paper will describe the application of this approach to a traditional industrial engineering course: Supply Chain Management Technology. Recommendations and considerations are provided for faculty interested in leveraging this standardized, holistic approach to integrating the entrepreneurial mindset into their courses, regardless of discipline.

2. Background

2.1 Role of Problem-Solvers in the Entrepreneurial Process

Organizations exist because they provide value. Value cannot exist without the intentional discovery, evaluation, and exploitation of opportunities [5]. Private for-profit enterprises, such as Publix Super Markets, Fidelity Investments, and McKinsey & Company, and publicly traded enterprises, such as Ford Motor Company, Nike, and Kellogg Company, offer value as captured through profits and return on investments. For non-profit firms, such as the YMCA and Habitat for Humanity, value can be captured through serving their societal mission (not necessarily to economically benefit founders or donors). For government entities, such as the Department of Energy and the Agency for International Development, value can be perceived through the pursuit of equality and justice as demonstrated through the development and revision of laws, policies, and public order. This process of value creation, with a particular focus on the role of engineers, is summarized in Figure 1 and further explained in the next paragraph.

Figure 1. The Role of Engineers in the Entrepreneurial Process [1]

It is the people working within the organizations who create value through the entrepreneurial process of discovering, evaluating, and exploiting opportunities. From a macro perspective, organizations drive the entrepreneurial process through the stages of discovery, evaluation, and
exploitation of an opportunity, all of which require the participation and engagement of individuals within an organization. The return on investment of employee time is highest when there is an association of value; and the most valuable designs (e.g., innovations) include validation of customer desirability, technology feasibility, and business viability. From a micro perspective, people (of all disciplinary backgrounds and all job titles) can intrinsically, or extrinsically, play a role in validating the most valuable design. People play a role by engaging in projects and tasks focused on problem-solving and value creation.

2.2 Curriculum Design Components

This section provides an overview of the standardized, holistic approach for integrating the entrepreneurial mindset into existing courses across the disciplines using the four curriculum design components [1].

#1: Curriculum Design for Entrepreneurial Integration

From a macro perspective, a learning experience should provide the ability to discover, evaluate, and/or exploit opportunities. When working towards developing the most valuable design(s), opportunities that create the most value should be derived from customer desirability, technology feasibility, and business viability. From a theoretical lens, these notions are grounded within the definition of the entrepreneurial mindset as “the inclination to discover, evaluate, and exploit opportunities [1]” and the most valuable design considerations to achieve desirability-feasibility-viability credited to Tim Brown of IDEO [6]. Together, the macro perspective and most valuable design perspective combine to create the entrepreneurial component. Then, the micro perspective is where to center in on the problem-solving process. Here, integration of the entrepreneurial component is encouraged in two locations. First, the learning objective(s) should include clear and observable learning expectations at the intersection of the course content area and the entrepreneurial component. Second, this will naturally result in the inclusion of the entrepreneurial component within the learning activity and learning assessment area. The purpose of designing for entrepreneurial integration is to ensure that instead of simply offering a stand-alone learning experience isolated from the entrepreneurial component, it is important to consider the entrepreneurial component with respect to the course content area. In other words, if teaching a course on food science, students should develop the entrepreneurial mindset within the context of food science instead of on its own without regard for the class topic area.

#2: Curriculum Design for Professional Skills

The learning experience should provide an opportunity to develop professional skills (collaboration and communication) or what are frequently described as “soft skills”. Industry and practitioner articles often remind higher education institutions of the need for graduates who excel in team environments and are effective in the exchange of information. It is important for the professional skills, including collaboration and communication, to be intentionally integrated into the learning activities and/or learning assessment. Group projects and project reports/presentations are relatively easy ways to practice and gain professional skills.
#3: Curriculum Design for Habit Development

The learning experience should provide occasions for continued practice, reflection, and feedback, which ultimately drive habit development. Here, it is important to remember that the entrepreneurial mindset focuses on one’s mental attitude and belief system, which is acquired and nurtured over time with continued practice, reflection and feedback. As explained by Carol S. Dweck, a change in mindset requires effort, practice, and challenging tasks [7]. Regardless of whether it is the entrepreneurial mindset or the growth mindset, practice and more practice can change one’s beliefs and attitudes, which in return can instill and reinforce the entrepreneurial mindset. Common methods for integrating practice, reflection, and feedback into the curriculum can be through semester-long scaffold projects, journaling, peer feedback, and formative assessments.

#4: Curriculum Design for Best Teaching Practices

The learning experience should incorporate best teaching practices including backward course design (aligning the learning goals and objectives with the learning activities and assessment) and general pedagogical approaches supporting the learning experience. Backward course design [8] encourages instructors to think about the learning goals and objectives prior to establishing the learning activities and assessments. But in the end, all should be in alignment. Just like strategic planning within an organization, it is important to acknowledge the goals first before defining tasks and anticipated outcomes to meet the goals. Other general pedagogical approaches supporting the learning experience are at the discretion of the instructor. Yet, an example of theoretical framing is provided here to give instructors a starting point. Ambrose et al. [9] provide compelling justification that motivation to learn is driven in large part by a combination of three factors: self-efficacy, seeing value, and a supportive environment. Self-efficacy refers to confidence in one’s ability to successfully complete a task. Self-efficacy can manifest itself as confidence in current knowledge, confidence in gaining access to knowledge (e.g., resourcefulness), or confidence in learning new knowledge (e.g., growth mindset). Research suggests as self-efficacy increases, so too will motivation to learn [10]. Seeing value relates to a goal’s perceived importance; as seeing value increases, motivation to learn increases. Value can manifest itself via attainment value (e.g., satisfaction gained from mastery), intrinsic value (e.g., satisfaction gained from complete a task), or instrumental value (e.g., satisfaction gained from extrinsic awards) [11]. Finally, a supportive environment encapsulates classroom dynamics and relates to one’s feeling of belonging within the classroom. Research tells us the more the environment is perceived to be supportive, the more motivation to learn increases [12].

3. Methods

3.1 Participants

This study was conducted at a research-intensive university in the Midwest United States. Participants included sophomore-level students enrolled in a three-credit course called Supply Chain Management Technology. The course is required for students enrolled in the Industrial Engineering Technology (IET) bachelor’s degree program, and also serves as an elective for non-IET majors. The total class enrollment was 103 students (across two sections), of which 72 students
completed the reflection evaluation assignment. The IRB protocol was approved as Exempt Level 1 (education research).

3.2 Intervention

The course description for Supply Chain Management Technology is as follows: “This course is an introduction to supply chain management technology. Topics include supply chain functions including how to organize a supply chain, supply chain strategy, supply chain process mapping, and use of supply chain technologies, analysis, and performance measurements.” Students participated in weekly online discussions (explained in 3.2.1) and completed three design projects (explained in 3.2.2), all of which integrated the entrepreneurial mindset. For the purpose of assessment, a metacognitive reflection assignment (3.3) was used to qualitatively explore student perceptions.

3.2.1 Using Online Discussions to Integrate the Entrepreneurial Mindset

The supply chain learning activity that integrates the entrepreneurial mindset includes twelve online discussion sessions to promote practice, reflection, and feedback. See Table 2, for example, discussion prompts. The online discussions were evaluated using a standard discussion rubric (6 points for the initial post and 4 points for responses posts).

#1: Curriculum Design for Entrepreneurial Integration: The entrepreneurial component is integrated using all three focus areas (e.g., entrepreneurship, characteristics of most valuable design, and problem-solving). As such, the learning objective is to demonstrate knowledge of innovative real-world commercial applications used within the supply chain industry.

#2: Curriculum Design for Professional Skills: Professional skills of collaboration and communication fit naturally into online discussion prompts. Students need to practice and apply written communication skills within the initial prompt, and the response prompt encourages collaboration among the group to understand the perspectives of others.

#3: Curriculum Design for Habit Development: Online discussions naturally allow for reflection (within the initial prompt) and feedback (when students are directed to respond to posts to keep the conversation going). Moreover, when online discussion assignments are implemented multiple times throughout the semester, this allows for practice. During the teaching of this course, online discussion assignments were issued every week (except for three project work weeks).

#4: Curriculum Design for Best Teaching Practices: With respect to backward course design [8], this series of online discussion sessions ensured alignment between the learning goal, learning objectives, learning activity, and learning assessment. Also, within the learning activity and learning assessment, best teaching and learning practices were applied through student empowerment to find and synthesize information (promoting self-efficacy), focus on real-world issues (identify real-world values), and students get to practice leading the discussions in a positive course climate (leverage supportive environment).
Table 2. Example Online Discussion Prompts for Supply Chain Management Technology

<table>
<thead>
<tr>
<th>Example Discussion Post #1: Global Supply Chain and Source Mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Initial Post:</strong> Part 2: Select a food item that is shipped to the U.S. from a different country. (1) What are the raw materials needed for this product? Where are they found? (2) What are the steps involved in making this product? Where does each step in the production take place? (3) What kind of transportation options are available at each stage of the production process, including getting the finished product to you? (4) Create a source map here: <a href="https://open.sourcemap.com/">https://open.sourcemap.com/</a> and upload it with your initial post.</td>
</tr>
<tr>
<td>• <strong>Response Post:</strong> Respond to at least the amount of responses) comparing and contrasting your post to their post. Minimum word count is 150 words.</td>
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<tr>
<th>Example Discussion Post #2: Technology Integration</th>
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<tr>
<td>• <strong>Initial Post:</strong> Select one of these supply chain data collection technologies: RFID, QR codes, GPS, sensors. (1) What is the technology? (2) What are the benefits of the technology to the supply chain? (3) What challenges exist with the technology? (4) Summarize and provide links to two real-world examples where the technology is being used to benefit the supply chain.</td>
</tr>
<tr>
<td>• <strong>Response Post:</strong> Respond to at least the amount of responses) comparing and contrasting your post to their post. Minimum word count is 150 words.</td>
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<tr>
<th>Example Discussion Post #3: Business Model Canvas</th>
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<tbody>
<tr>
<td>• <strong>Initial Post:</strong> (1) Explain how each of the 6 drivers of supply chain performance [13] relates to each of the 9 components of the business model canvas [14]. (2) Select a company from the list here and respond to the following questions: Apple, Seven-Eleven, Redbox, Zara, Amazon, Anderson Windows, W.W. Grainger, Macy’s, Sunsweet Growers, McMaster-Carr, Netflix, or Blue Nile</td>
</tr>
<tr>
<td>□ What is the primary <strong>Customer Segment</strong>? Explain.</td>
</tr>
<tr>
<td>□ What is the primary <strong>Value Proposition</strong>? Explain.</td>
</tr>
<tr>
<td>□ What <strong>Channels</strong> are used to create awareness? Inform evaluation? Make purchases? Allow delivery? Permit after sales? Explain each of the five.</td>
</tr>
<tr>
<td>□ What <strong>Customer Relationships</strong> are key? Explain.</td>
</tr>
<tr>
<td>□ What key <strong>Revenue Streams</strong> exist? Explain.</td>
</tr>
<tr>
<td>□ What <strong>Key Resources</strong> are required? Explain.</td>
</tr>
<tr>
<td>□ What <strong>Key Activities</strong> are performed? Explain.</td>
</tr>
<tr>
<td>□ What <strong>Key Partnerships</strong> exist? Explain.</td>
</tr>
<tr>
<td>□ What primary <strong>Cost Structure</strong> is deployed? Explain.</td>
</tr>
<tr>
<td>• <strong>Response Post:</strong> Respond to at least the amount of responses) comparing and contrasting your own post to their post. What is similar? What is different? What might be missing? Minimum word count is 150 words.</td>
</tr>
</tbody>
</table>
3.2.2 Using Projects to Integrate the Entrepreneurial Mindset

The learning activity includes three design projects spread throughout the semester. See Table 3 for one example design project for the Supply Chain Management course. The project was evaluated using standard report and presentation rubrics.

Table 3. Example Project for Supply Chain Management Technology

| Preparation: Read this article, titled “Gartner Announces Rankings of the 2019 Supply Chain Top 25.” Select one of the top 25 companies you find the most interesting and respond to the project with that company in mind. Only one team per company. |
| Part 1: Company Background |
| 1. 1 page of text: Provide an introduction to the company with a high-level overview of why the supply chain is so innovative. |
| 2. 1 page of text: Describe the company with respect to the 6 drivers of supply chain performance [13]. |
| 3. 1 page of text: Describe the company with respect to the six distinct distribution network designs [13]. |
| 4. 1 page of text: Describe the company using a minimum of 4 factors that influence network design decisions in supply chains [13]. |
| Part 2: Strategizing |
| 1. 1 page of text: Provide a brief overview of the Business Model Canvas. Describe the company with respect to each of the 9 Business Model Canvas components (focusing on one value proposition-customer segment combination). |
| 2. 1 page of text: Provide a brief overview of the Value Proposition Canvas. Describe the company with respect to each of the 4 Value Proposition Canvas components (focusing on one value proposition-customer segment combination). |
| 3. 1 page of text: Provide a brief overview of the Supply Chain Canvas. Describe the company with respect to each of the 5 Supply Chain Canvas components (focusing on one value proposition-customer segment combination). |

#1: Curriculum Design for Entrepreneurial Integration: The entrepreneurial component is integrated using all three focus areas (e.g., entrepreneurship and characteristics of most valuable design). As such, the learning objective aims to demonstrate knowledge of innovative real-world commercial applications used within the supply chain industry.

#2: Curriculum Design for Professional Skills: Professional skills of collaboration and communication are exploited by having students work in teams and submit a report and presentation.

#3: Curriculum Design for Habit Development: All projects were scaffolded in that students got to practice and receive feedback three times before the final grading. Also, the metacognitive assignments reinforced the need for reflection within the classroom.
#4: Curriculum Design for Best Teaching Practices: With respect to backward course design [8], this series of online discussion sessions ensured alignment between the learning goal, learning objectives, learning activity, and learning assessment. Also, within the learning activity and learning assessment, best teaching and learning practices were applied through student empowerment to find and synthesize information (promoting self-efficacy), focus on real-world issues (identify real-world values), and students get to practice leading the discussions in a positive course climate (leverage supportive environment).

3.3 Data Collection and Analysis

The data collection employed a metacognitive reflection instrument (Table 4), grounded in the work completed by Ambrose et al. [9]. The first question requires students to apply the cycle of self-directed learning whereas the latter two questions focus on student motivation to learn. The data analysis followed a qualitative approach using thematic analysis. According to Braun and Clark [15], a thematic analysis is a foundational qualitative method for discovering patterns within the data. It should be conducted using a step-by-step process. The NVivo 12 qualitative analysis software was used to code the reflections. The researchers first become thoroughly familiar with the data to generate initial codes. Then, the researchers reviewed and analyzed the documents several times. Upon the completion of coding, themes were generated. As a final step, the researchers revised the themes and drafted the results. Due to the qualitative nature of the research, the goal of the analysis was to explore potential themes within the data. The researchers debated the strengths and weaknesses between strictly conceptualizing themes without quotes and heavily using quotes to provide readers with evidence. It was decided to merge the two philosophies and meet in the middle. Quotes were drawn from the data to allow readers to make their own judgments on credibility, accuracy, and fairness [16].

<table>
<thead>
<tr>
<th>Table 4. Example Metacognitive Reflection Assignment</th>
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<tbody>
<tr>
<td>1. Metacognitive Post-Assessment (1 page minimum)</td>
</tr>
<tr>
<td>• After completing the assignment, identify what you learned and insights you gained, and how you might approach a similar assignment in the future. Things to consider: What professional skills were gained? What course topic knowledge was acquired? How was your peer’s approach to the assignment different from your approach? Based on the findings, how might you approach an assignment like this in the future? When did you start working on the assignment? How much time did you dedicate to the assignment? Do you think this is adequate? Why or why not? In the future, how might you approach an assignment like this again?</td>
</tr>
<tr>
<td>2. Summary of Why this Matters (1/2 page minimum):</td>
</tr>
<tr>
<td>• Identify what type of job or career you might like to have in the future. Why is this competency important for this type of job? Why are assignments like these important in preparing you for entering the workforce? Why are the concepts, skills, and prior knowledge required for assignments like these important to future employers?</td>
</tr>
<tr>
<td>3. Lifelong Learning (1/2 page minimum)</td>
</tr>
<tr>
<td>• In the future, how might you extend your knowledge related to this competency area? Be specific in identifying a minimum of 5 diverse resources (e.g., people, books, movies, government agencies, MOOCs, magazines, websites, educational institutions, courses, museums, conferences, etc…)</td>
</tr>
</tbody>
</table>
4. Results and Discussion

The preliminary analysis resulted in three themes including a focus on (1) self-efficacy and skill development, (2) seeing value by connecting theory to practice, and (3) improving access to knowledge by building a supportive environment.

4.1 Self-Efficacy and Skill Development

Analysis of the data demonstrates self-efficacy and skill development attainment with respect to both contextual knowledge (as it relates to entrepreneurial integration) and procedural knowledge (as it relates to professional skill development and habit development).

Example quotes for contextual knowledge are provided here:

- “I did not expect to learn meaningful application to the real world. But I did learn a lot more about the supply chain and how to apply it to a real-world example.”
- “I gained some knowledge such as how technology integrates into the supply chain, and why real-time statistics are important.”
- “My part was to describe the company we chose in terms of the six design network distribution networks. My knowledge on that particular context did increase because I've never had to think in those terms for any company.”
- “I learned a lot about how CVS operates their supply chain, and some of the advancements in technology they are making to improve their knowledge of customer demand, which influences their supply. My ratings improved in my ability to understand the value proposition canvas and how to identify customer gains from gain creators.”

Example quotes for procedural knowledge are provided here:

- “I learned that group members need to be trusted to complete their portions on time and that some portions build on others. This is key when working in groups. My skills were tested and my analytical thinking was improved while doing research for this project.”
- “[Given the group project], I learned that I am more of a leader than I thought I was. Yet, time management was an issue. If I approached it again I would try to find other ways to counter my burnout.”
- “I improved skills like writing and self-editing through practice with the paper. I feel more confident in using these skills after writing the paper.”
- “I learned that teamwork is very beneficial in project settings. Each of our strengths and weaknesses work together to produce a project that we are all proud of. I grew deeper in my confidence and ability to think outside my comfort zone.”
- “I think I improved my researching skills throughout because I began to notice better ways to look up information.”

In summary, although students were able to recognize and communicate knowledge gains concerning contextual knowledge or procedural knowledge, very few students stated knowledge gains within both categories. Moving forward, the metacognitive reflection assignment prompts
will be updated to encourage students to reflect upon and respond to both categories, as both are important for developing the entrepreneurial mindset.

4.2 Seeing Value by Connecting Theory to Practice

Analysis of the data showcases the students’ ability to see value in connecting the theoretical classroom to the practical workplace. In general, students reflected upon the benefits as it relates to working for a company, and/or starting one’s own business. Example quotes are provided here:

- “This is important to me because it shows that if I want to have my own business, these are the things that I would need to do to have a somewhat of a successful business. But these are important for future employers too because once they hire you, you can tell them what you have learned and maybe increase the business in a profitable way.”
- “I’m currently awaiting a response from Amazon’s information technology department on an internship position with their company. This project directly correlates to this because of Amazon being the main supplier in just about anything that would be needed by consumers, and therefore implementing the supply chain and all aspects of it into their business.”
- “I am interested in being a business analyst in a consultant firm. This assignment is important because it’s very similar to the business consultant’s job task. some of the required knowledge would be analytical skills, online researching skills, business writing skills, etc.”
- “I would like to have a job in the agriculture industry, and analyzing a supply chain like we did in Project 1 will allow me to apply this knowledge to my future career. The agriculture supply chain is complex due to the seasonality of production and the biological aspect of its constituent products. Employers will be glad to see that I have prior experience evaluating a supply chain because it will show that I can apply my experience to the employer’s supply chain.”
- “This class is preparing me for the future by teaching me all the steps that go into having a successful business. This information is important to future employers because it shows you have knowledge that will help grow the company.”

In summary, students were able to recognize and communicate why the course content was valuable and how it can be used in the future either by working for an organization or through starting a business. From an instructor’s perspective, it was beneficial to see the wide variety of jobs and industries where students planned to work. Moving forward, a pre-class survey will be sent out to obtain this information in advance. Then, throughout the semester, assignments (including in-class participation, online discussions, and projects) can be modified to use more examples contextualized to student interest.

4.3 Improving Access to Knowledge by Building a Supportive Environment

Analysis of the data highlights students’ capacity to improve knowledge access by building a supportive environment. In general, only about 1/3 of the student were specific in their responses. Example quotes are provided here:
• “In the future, the way that I will extend my knowledge is to make myself acquainted with major executives in any company that I come across. Another way is to keep up on any major news about the company that I could find in magazines or newspapers.”
• “In the future, I plan to extend my knowledge by reading different books (such as Principles by Ray Dalio).”
• “In the future, I would extend my knowledge mostly through the internet. The internet is my preferred choice because there are dozens of articles available that will show an unbiased opinion if you fact check one article against the other.”
• “I will extend my knowledge simply by trial and error. People make mistakes and it's important to try and learn from them.”
• “Top 25 business magazines can give me an insight into successful business practices. With this, I could identify companies where I could do a grounds tour of a factory site to see some of these practices in person or interview a current Sales Engineer to hear more about how they use this information in their line of work.”

In summary, students were able to recognize and communicate how to extend their knowledge access in the future by building a supportive environment. Given that only about 1/3 of the student responses provided specific examples, moving forward, updates will be made to the metacognitive reflection prompts and/or time will be afforded with the lecture to provide students with greater structure and practice in identifying specific examples (which should increase the likelihood of those resources being sought out in the future).

5. Conclusion

5.1 Summary and Contribution

In conclusion, this study offers several contributions to the industrial engineering education literature. First, the study demonstrated how to use a standardized, holistic for integrating the entrepreneurial mindset into an existing industrial engineering course using the four curriculum design components obtained from the text, “Teaching the Entrepreneurial Mindset to Engineers” [1]. Second, the study demonstrated the efficacy of this approach through implementing and qualitatively analyzing metacognitive reflection assignments borrowed from the text, “How Learning Works: Seven Research-Based Principles for Smart Teaching” [9]. Here, findings show student perceptions of learning and knowledge gain with respect to self-efficacy, seeing value, and building a supportive environment. Third, the study provided lessons learned for improving upon instructional practices in future classroom settings. Although the example focused on one industrial engineering course (i.e., Supply Chain Management Technology), we are confident this standardized, holistic approach can be applied to other industrial engineering courses specifically, and other engineering classrooms in general.

5.2 Limitations and Future Research

This study has three major limitations. First, the study employed a qualitative approach using thematic analysis of metacognitive reflection assignments. Although a qualitative approach offers a great depth and richness, especially for exploring the phenomena, future research would benefit from the integration of quantitative explanatory data analysis related to student learning outcomes.
and student satisfaction. Second, the entrepreneurial mindset integration was limited to one industrial engineering course on Supply Chain Management Technology. Future research would benefit from implementing the four curriculum design components in other industrial engineering and other engineering classrooms. Third, the study was completed with one classroom where data collection was completed at the end of the course. Future research would benefit by analyzing larger sample sizes, varying student demographics, different higher education institutions, and from a longitudinal perspective (to quantify long-term knowledge gains).

5.3 Concluding Remarks

The 2021 Suez Canal debacle demonstrates a greater need to understand the implications for disruptions to the global supply chain, and the benefit of using industrial engineering and entrepreneurially-minded concepts to evaluate and overcome these disruptions. As one corporate executive recently stated [17], “Disruptions caused by the pandemic, and now this shipping crisis in the Suez Canal, clearly serve as a warning to companies across the board: Don’t wait for an unexpected crisis to wreak havoc on your business. The tools now exist to proactively plan and protect your interests. And most of those tools are powered by AI and data. A proactive, data-driven approach to a disruption - like the supply chain chaos caused by the ship grounding in the Suez Canal - could significantly mitigate the business impact. Real-time data about inventory, demand, projected demand, and alternate supplies, when run through properly trained AI Platforms can render surprisingly effective contingency plans.”

6. References


