Student Perceptions of Learning in Cooperative Education Experiences, An Embedded Mixed Methods Study

Katherine Ehlert

Clemson University, katherine.ehlert@gmail.com

Follow this and additional works at: https://tigerprints.clemson.edu/all_dissertations

Recommended Citation
https://tigerprints.clemson.edu/all_dissertations/2695
STUDENT PERCEPTIONS OF LEARNING IN COOPERATIVE EDUCATION EXPERIENCES, AN EMBEDDED MIXED METHODS STUDY

A Dissertation
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy
Engineering and Science Education

by
Katherine Marie Ehlert
August 2020

Accepted by:
Dr. Marisa K. Orr, Committee Chair
Dr. Lisa C. Benson
Dr. Karen High
Dr. William C. Bridges
ABSTRACT

Calls for improved educational practices within the field of engineering are focusing on content delivery, suggesting that authentic engineering tasks will better prepare students for engineering in the 21st century. Cooperative education (co-op) can provide such experiences. Studies indicate students who have participated in co-op programs typically graduate with higher GPAs, have an easier time transitioning into full-time work, and begin working at higher starting salaries. Although successful outcomes of co-op have been documented, little is documented on the ways in which co-op provides these benefits. The purpose of this embedded mixed methods study is to document student perceptions of what and how they learn while on co-op. This was achieved using an analysis approach that was designed to systematically measure and document viewpoints known as the Q-methodology. Twenty-eight students sorted 42 statements related to learning on co-op and were interviewed to better understand their perspective and interpretation of the statements. Results of this study indicate four unique views about learning on co-op. Twenty-two of the participants factored into one of the following groups: The Problem Solvers, The Apprentices, The Doers, and The Deciders. The remaining six participants expressed views that aligned with more than one of the four groups. This process identified student-driven language centered around learning in co-ops, which can help researchers build better instruments that measure aspects of learning on co-op or other experiential learning opportunities. Additionally, this work can provide co-op administrators a language for students and mentors to utilize when discussing roles, expectations, and responsibilities.
DEDICATION

This work is dedicated to my family for all the love throughout my life. To my Mom and Dad, my brothers and sisters-in-law, my nieces and nephew, and my husband. Your love makes life so much easier. Also, to my grandfather, George, who believed I could do anything, including playing baseball or, for me, earn a PhD.
ACKNOWLEDGMENTS

In creating this work, there were many times where I felt pure joy and pride and, I think, an equal number of times where I felt frustration and confusion, but writing this section of my dissertation is, without a doubt, full of joy and gratitude. I cannot appropriately express my thanks for all those that have supported me along this ten-year journey from realizing that teaching was my calling to the completion of this dissertation. Throughout those years, I relied on so many friends, colleagues, mentors, and other sources of support, especially when the path took turns so sharp that I lost sight of this day. To you all, I am forever grateful. You saw my passion and fire when I could not see it in myself.

First, I would like to thank the Cooperative and Experiential Education Division (CEED) of the American Society for Engineering Education for financially supporting this work. Thank you for supporting this work and being as excited about the results as I am.

I would also like to acknowledge my adviser, Dr. Marisa Orr, for all the support and encouragement throughout this process. I cannot express how impactful your mentorship and support has been to me. There were so many times when I wanted to give in or give up, but you would not allow it and I will be forever grateful for that. You pushed me beyond what I believed I was capable of and helped me create a dissertation that I love and am proud to share. Thank you for taking a chance on me and for never letting me walk away from my passion in co-op research. If I have half the impact on my students as you have had on me, I will know that I have become an amazing adviser.
I would also like to thank my other committee members, Drs. Lisa Benson, Karen High, and William Bridges for taking every meeting with me and supporting the development of my work by always being excited about what I shared and challenging me to go deeper. The quality of my work is a testament to your talents and your ability to see the potential in what I was creating. I hope that we can continue collaborating on this work and many others moving forward.

I would like to thank the rest of the Engineering and Science Education family; the current students, the faculty, and the many alumni who are doing amazing work. I am so very proud of the department we have all helped shape and the work that you are all doing. To the current students: keep pushing and try to not lose sight of your final goals. I know you all are capable of achieving them. Know that I am here to cheer you on and help you along the way. To the recent alumni, especially Aubrie, Justine, Gus, and Catherine. Thank you for welcoming me into the department and always being there to listen to and encourage me or constructively criticize my work so that I could become the best researcher I could be. To my two closest ESED friends and Spring graduates, Dennis and Khushi. In these past four years, we have grown together as researchers and I am so happy that we will now be colleagues. I look forward to seeing the amazing work you will do in your future.

Thank you to my research team M and G for always being there to listen to my ideas, be the calming presence in my times of need, or give me permission to take the evening off when my brain was just too tired to move forward. M, thank you for your copy
editing support, always watching what words I put on the page and G, thank you for being willing to stay up and let me get to those big ideas that moved the research forward.

Thank you to all the researchers that have helped shape my work or help me complete my journey. Adam Kirn, Allison Godwin, Justin Major, Baker Martin, Cass McCall, and countless others. I look up to and respect you all for your contributions. Thank you for asking the right questions and challenging me in the right ways so that I could complete this marathon.

To my participants: thank you for sharing a part of yourself with me. Your openness, honesty, and bluntness has truly helped my work. I hope to continue to advocate for you and for better co-op opportunities for those that come after you.

Dr. Iwan Alexander, I will be forever grateful to you for seeing my potential for research when I was a young college student and for continuing to support me along my circuitous path to my Ph.D. Thank you for taking time to talk with me, guide me, and share your perspective on what would be the best step forward. You are a mentor and a teacher that I hope to emulate for the next generation of students.

To my sorority siblings in Sigma Psi, especially my closest sisters, Maggie, Eva, Deborah, Annie, Sherry, and Ceylan, thank you for creating a home for me on campus and a space where I could grow into the person that I am today. Thank you for challenging me to do better, to be better, and to continuously strive to serve the community in which I live. This work is shared with you and for the newest generations of Sigma Psis yet to come, in earnest and sisterly love.
To my beloved Becca, thank you for welcoming me to Philadelphia and always being around to share the beautiful city with me. Thank you for always loving me and for being one of the biggest sources of support when I up and moved 1,000 miles away to start this degree. Thank you for inspiring me to continue to show love and share my love with others.

I would like to thank my family, and their unfailing love. To my parents, George and Georganne, thank you for never letting me forget that the sky wasn’t even a limit. You have always had my best interest at heart and have always wanted to see me shine. I hope that in this work and my future work you see the radiant researcher that I have become.

To my brothers Steve and Greg, thank you for dealing with me and all my antics. You are both amazing researchers and I have always looked up to you. Thank you for recognizing the work that I have put into this and for being there to support me throughout both graduate school journeys. To my sisters-in-law Julie and Nancie, thank you for your support and love as well. I’m so grateful to now have women I can call my sisters and I can’t think of better ones than you. To my nieces, Avery and Mackenzie, and my nephew, Matthew, you are the next generation that will move this world forward. Never forget your power, your purpose, and your potential.

To my grandfather George, I am sorry that you could not see this day in person, but I know you are looking down on me and smiling. I know being a girl was a bit of a curveball after eight grandsons and planning for your own baseball team, but the love and affection you shared with me throughout my years will not be forgotten. You always treated me as
special, but never treated me as delicate. I hope that I have and will continue to make you proud.

To my husband, Robby, your unfailing support made the tough days easier to weather and the wonderful days more enjoyable to take in. You truly have seen every up and down since my qualifiers and I cannot think of a better person to share the rest of my life with. You are a true partner, quietly doing whatever needed to be done to help ease my stress and never demanding a ‘thank you’. Thank you for making those extra dinners, for not complaining when I was less than kind, for the notes of love and encouragement, and for all the tears you dried along the way. Every day I see a new way to love you and a new way you are expressing your love to me. I don’t know how I would have made it without you by my side, but I’m glad you have been here. Thank you for taking a chance on me and loving me for exactly who I am. I look forward to sharing the rest of our lives with each other, wherever that may take us. I love you, forever and always.

Lastly, I want to thank Dr. Courtney Faber for being an inspiration and introducing me to the field of engineering education, for helping me jump from industry back to academia, and for all the mentorship along the way, after all, this is all your fault.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>ii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xiv</td>
</tr>
<tr>
<td>CHAPTER 1: Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Personal Motivations to Study Co-op</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Academic Motivations to Study Co-op</td>
<td>2</td>
</tr>
<tr>
<td>CHAPTER 2: Background of Cooperative Education</td>
<td>7</td>
</tr>
<tr>
<td>2.1 History of Co-op</td>
<td>7</td>
</tr>
<tr>
<td>2.2 Definition of co-op</td>
<td>9</td>
</tr>
<tr>
<td>2.3 Research about co-op</td>
<td>10</td>
</tr>
<tr>
<td>2.4 Conclusions</td>
<td>16</td>
</tr>
<tr>
<td>CHAPTER 3: Theoretical Perspectives</td>
<td>17</td>
</tr>
<tr>
<td>3.1 Kolb’s Experiential Learning Theory</td>
<td>18</td>
</tr>
<tr>
<td>3.2 Lave &amp; Wenger’s Situated Learning</td>
<td>19</td>
</tr>
<tr>
<td>3.3 Social Cognitive Career Theory</td>
<td>20</td>
</tr>
<tr>
<td>3.4 Metacognition</td>
<td>21</td>
</tr>
<tr>
<td>3.5 Conclusion</td>
<td>22</td>
</tr>
<tr>
<td>CHAPTER 4: Methodology</td>
<td>25</td>
</tr>
<tr>
<td>4.1 Q-Methodology and its steps</td>
<td>27</td>
</tr>
<tr>
<td>4.2 Advantages of Q-Methodology</td>
<td>29</td>
</tr>
<tr>
<td>4.3 Differences Between Q and R</td>
<td>29</td>
</tr>
<tr>
<td>4.4 Terminology</td>
<td>30</td>
</tr>
</tbody>
</table>
Table of Contents (Continued)

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Research Design</td>
<td>31</td>
</tr>
<tr>
<td>5.1</td>
<td>Statement Development</td>
<td>31</td>
</tr>
<tr>
<td>5.2</td>
<td>Pilot Study</td>
<td>35</td>
</tr>
<tr>
<td>5.3</td>
<td>Participant Selection and Recruitment in the Full Study</td>
<td>44</td>
</tr>
<tr>
<td>5.4</td>
<td>Q-sort and Interview</td>
<td>48</td>
</tr>
<tr>
<td>5.5</td>
<td>Quality and Legitimation Considerations</td>
<td>49</td>
</tr>
<tr>
<td>6</td>
<td>Data Analysis</td>
<td>56</td>
</tr>
<tr>
<td>6.1</td>
<td>Q-factor Analysis</td>
<td>56</td>
</tr>
<tr>
<td>6.2</td>
<td>Qualitative Analysis</td>
<td>62</td>
</tr>
<tr>
<td>6.3</td>
<td>Factor Profile Development</td>
<td>63</td>
</tr>
<tr>
<td>7</td>
<td>Results and Discussion</td>
<td>65</td>
</tr>
<tr>
<td>7.1</td>
<td>Summary of Factors</td>
<td>65</td>
</tr>
<tr>
<td>7.2</td>
<td>Developing the Profiles</td>
<td>75</td>
</tr>
<tr>
<td>7.3</td>
<td>Cross Factor Analysis</td>
<td>128</td>
</tr>
<tr>
<td>7.4</td>
<td>Ungrouped Participants</td>
<td>133</td>
</tr>
<tr>
<td>7.5</td>
<td>Triangulation</td>
<td>152</td>
</tr>
<tr>
<td>8</td>
<td>Conclusions</td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>Implications</td>
<td>158</td>
</tr>
<tr>
<td>8.2</td>
<td>Limitations</td>
<td>159</td>
</tr>
<tr>
<td>8.3</td>
<td>Future Work</td>
<td>160</td>
</tr>
<tr>
<td>APPENDICES</td>
<td></td>
<td>163</td>
</tr>
<tr>
<td>APPENDIX A: Mapping of Statement Phrases</td>
<td>164</td>
<td></td>
</tr>
<tr>
<td>APPENDIX B: Email Invitation and Survey</td>
<td>167</td>
<td></td>
</tr>
<tr>
<td>APPENDIX C: Interview Questions</td>
<td>169</td>
<td></td>
</tr>
<tr>
<td>APPENDIX D: Three Word Combination for Statements</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>APPENDIX E: Visuals of the Factor and Individual Sorts</td>
<td>174</td>
<td></td>
</tr>
<tr>
<td>REFERENCES</td>
<td></td>
<td>207</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 5-1: Table of what was learned (skills) and how that learning could occur on co-op with skills. Learning statements that mapped to specific theories are noted in the secondary column................................................................................................................... 34

Table 5-2: Table of all the statements used in the pilot data and their corresponding scores for each participant. The Notes column indicates which statements were removed for the full study. ......................... 39

Table 5-3: Self-reported demographics of the students who participated in the survey. ........................................................................................................ 45

Table 5-4: Demographic information of each participant........................................ 46

Table 5-5: Definitions for Legitimation Framework. .............................................. 50

Table 5-6 Definitions in Q3 Framework .................................................................. 51

Table 6-1: Summary of the number of participants in each factor and the total number of participants factored for each factoring solution evaluated. ......................................................................................... 58
List of Tables (Continued)

Table 6-2: Factor assignments for each participant and factor solution. Participants are ordered by the 7-Factor solution assignment to better show how different participants are members of different groups depending on the number of factors. Note: a factor assignment of 0 indicates that the participant did not sort into any of the factors. ................................................................. 59

Table 7-1: Factor loadings for all of the participants. Loadings that are dark and bolded indicate a statistically significantly loading for that factor............................................................ 69

Table 7-2: Table of all distinguishing and consensus statements for this study. Number of * indicates significance level (* p<0.05, ** p<0.01, *** p<0.001, **** p=0.000). ................................................................. 71

Table 7-3: Table of demographic information for Factor 1: The Problem Solvers.................................................................................................................. 77

Table 7-4: Table of demographic information for Factor 2: The Apprentices .................................................................................................................. 90

Table 7-5: Table of demographic information for Factor 3: The Doers .................................................................................................................. 107
List of Tables (Continued)

Table 7-6: Table of demographic information for Factor 4: The Deciders ........................................................................................................................................................................................................................................................................................................... 119

Table 7-7: Frequency counts for each "what" statement and its location in the representative factor Q-sort. Numbers in parentheses represented the total number of statements associated with each column or row. For example, there were three statements relating to learning “to work as part of a team” whereas five statements relating to learning “what to expect as an engineer”. ........................................................................................................................................................................................................................................................................................................... 131

Table 7-8: Frequency counts for each "how" statement and its location in the representative factor Q-sort. Numbers in parentheses represented the total number of statements associated with each column or row. For example, there were nine statements relating to learning “by repeated practice in real-world situations on my team” whereas seven statements relating to learning “from my own successes and failures”........................................................................................................................................................................................................................................................................................................... 132

Table 7-9: Table of factor loadings for just participants that did not load onto a single factor........................................................................................................................................................................................................................................................................................................... 133
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-1</td>
<td>Figure that relates the four theoretical perspectives to each other and the co-op experience.</td>
<td>23</td>
</tr>
<tr>
<td>5-1</td>
<td>Flowchart of the study showing the critical timepoints of development or analysis.</td>
<td>31</td>
</tr>
<tr>
<td>5-2</td>
<td>Figure showing the influence of theories on statement development.</td>
<td>33</td>
</tr>
<tr>
<td>5-3</td>
<td>Visual of the quasi-normal distribution that was used for the pilot study.</td>
<td>35</td>
</tr>
<tr>
<td>5-4</td>
<td>Image of the back of the sorting cards showing the numbers and tape used to record the score for each participant's sort.</td>
<td>44</td>
</tr>
<tr>
<td>5-5</td>
<td>Visual of the quasi-normal distribution that was used for the full study.</td>
<td>49</td>
</tr>
<tr>
<td>7-1</td>
<td>Image of a representative sort for Factor 1 of the 4-Factor solution. Statements with bolded borders were identified as distinguishing statements for this specific factor.</td>
<td>74</td>
</tr>
</tbody>
</table>
List of Figures (Continued)

Figure 7-2: Example image of a participant sort, Charlie. This is a
digital representation of the location of the prompts from
Charlie's Q-sort. Statements with bolded borders were
identified as distinguishing statements for Factor 1. ................................. 74

Figure 7-3: Representative Q-sort for Factor 1. Boxes with a bolded
border were identified as a distinguishing statement for this
factor. .................................................................................................................... 79

Figure 7-4: Representative Q-sort for Factor 2. Boxes with a bolded
border were identified as a distinguishing statement for this
factor. .................................................................................................................. 92

Figure 7-5: Representative Q-sort for Factor 3. Boxes with a bolded
border were identified as a distinguishing statement for this
factor. .................................................................................................................. 109

Figure 7-6: Representative Q-sort for Factor 4. Boxes with a bolded
border were identified as a distinguishing statement for this
factor. .................................................................................................................. 121

Figure 8-1: Model relating the four theories used in the study and
how they connect to the co-op experience. ......................................................... 157
CHAPTER 1: INTRODUCTION

1.1 Personal Motivations to Study Co-op

My first big exposure to the world of cooperative education experiences (co-op) happened when I was a junior in college. I realized that I was ahead of my coursework and could take a semester off and work at a manufacturing company. I enrolled in the co-op program at my university and I was offered a position at a local manufacturing plant called Precision Castparts Corporation (PCC). The PCC plant that I worked for manufactured large blades to be used in industrial turbines which were typically used to make electricity. I worked with the full-time engineers to help improve manufacturing practices to reduce the amount of scrap (i.e. products that did not meet specifications) or the amount of time it took to process a part.

I had a number of roles and was asked to perform a variety of tasks that ranged from adding wax to a part because there were not enough assembly-line workers to modifying inspection standards and presenting those recommended changes to valuable customers. Through this experience, I found that I would say that “I learned a lot” but had trouble describing the specific skills and knowledge that I learned from my co-op that could be transferrable to other environments. However, there were two critical pieces of knowledge that I took away from my experience: (1) you cannot convince your supervisor to invest in something unless you can argue that it will save money and (2) the engineers that were doing the most interesting work had advanced degrees. While the former helped me build better arguments, the latter motivated me to seek an advanced degree.
After completing my master’s degree in mechanical engineering, I moved to the Philadelphia office of an engineering and science consulting company called Exponent, Inc. The office was located across the street from Drexel University, an institution known for their embedded co-op program, in which our office was a significant participant. We had three co-op students at any time and the students would return to their studies after approximately six months of work. Many of the co-op students would return to our office for all three co-op rotations, so I could see the growth and impact that the co-op experience was having on them. This was where I started to realize that co-op was affecting how students approached their academics and influenced how they saw their curriculum fitting in their career trajectories.

Working closely with these students at Exponent and having participated in co-op myself inspired questions that I begin to answer in this dissertation. I have worked diligently throughout the dissertation to ensure that my prior experiences did not drive my interpretations or conclusions; however, they were the driving force behind my excitement and interest in this area. I hope this work can help contribute to the greater body of knowledge on co-op and the benefits that can be realized from that experience.

1.2 Academic Motivations to Study Co-op

There is an ever-increasing demand for well-trained engineers that can produce creative and innovative solutions to current complex world problems [1]–[4]. These problems extend beyond technological development and have major impacts on society. The National Academy of Engineering has described the most critical problems in their *Grand Challenges* report including making “solar energy economical”, to “engineer better
medicines”, and to “engineer the tools of scientific discovery” [1]. These multifaceted problems, which span social and technological needs, can only be solved by engineers that not only have a solid understanding of engineering concepts, but also strong professional skills like communication, collaboration, and team management. Beyond contributing to successful problem-solving in industry, these professional skills also enable companies in the US to remain competitive in an increasingly global economy [2], [5].

However, current academic programs are not preparing students to effectively operate in industry which is shown through the struggle newly graduated students experience transitioning to full-time work [6]–[9]. Scholars believe this transitional struggle is a result of the differences between the skills and knowledge that are valued in school and those that are valued in the workplace [6], [8], [9]. The Engineering Pathways Study reported that many students did not expect that the types of problems in the workplace would be so variable and complex which students felt underprepared to solve [6]. Additionally, most early-career engineers claim that work experience was the only way in which they could develop the skills necessary to navigate in their work environments [9]. More evidence related to this knowledge/skill gap between the engineering curriculum and industry is seen through the calls to action for engineering educators to reform and improve engineering curriculum from industry, engineering educators, and national academies [10]–[12].

Many approaches to address this educational gap fall within the umbrella of work-integrated learning. Work-integrated learning (WIL) is a general term for “a range of approaches and strategies that integrate theory with the practice of work within a
purposefully designed curriculum.” [13, p. v], with the key being that the work is *purposefully integrated into the curriculum*. WIL can include experiences like cooperative education, practicums, clinicals/clinical education, service learning, and others [13]. In general, WIL helps students build professional skills, improve their work readiness, apply theory to practice, and gain an understanding of what is expected in their field [13].

Beyond developing professional skills and the ability to navigate the complex social environment of the workplace, WIL provides context and experience that students can then bring back into the classroom. The authors of *The WIL Report* state that within a students’ field, WIL provides them “with the opportunity to demonstrate their understanding in authentic and meaningful contexts” [13, p. 13]. These authentic and meaningful contexts provide a space for students to apply concepts learned in the classroom to real-world events, expanding their understanding of fundamental phenomenon and the limitations of theories presented in an undergraduate curriculum.

One form of WIL common in engineering disciplines is cooperative education (co-op) which immerses students in the field of engineering and allows them to practice as an engineer. According to the Cooperative Education and Internship Association, co-op is defined as a “structured method of combining classroom-based education with practical work experience”, providing academic credit for work experience [14]. Co-op programs alternate school and work experiences either on the quarter, semester, or annual basis with each work experience often being referred to as a “rotation”. Large quantitative studies have shown students who co-op are more likely to graduate with an engineering degree [15] and often perform better academically, earning better grades in their upper-level
classes [16] and graduating with higher GPAs [17], [18]. This could be because students with engineering work experience had better problem-solving skills and a better understanding of the design process [19]. Additionally, students who co-op tend to be more successful in industry as they typically take jobs in the same field [20], have an easier time transitioning to full time work [21], have higher career self-efficacy [22]–[24], and earn higher starting salaries [18], [25].

Johnston, Angerilli, and Gajdamaschko [26] were able to begin documenting perceptions of learning while on co-op by comparing viewpoints between students and co-op administrators from British Columbian institutions. From their data, they found eight groups of participants that had varying views of learning while on co-op. For the most part, students were represented by six groups and practitioners were represented by two groups. Student views on co-op fell under these categories: (1) Co-op is for learning technical skills, (2) Co-op builds skills that enable students to be employable (professional skills), (3) Co-op is about learning and understanding their intended field, (4) Co-op is for the application of school-learned skills to the workplace, (5) Co-op complements the learning that happens in schools, (6) Co-op provides no additional value over other related work experiences (anti-co-op).

Although some administrators were represented in many of the “student” groups, two additional groups were dominated by co-op administrators and emphasized that either the administrator, or the structure of the co-op program best fostered learning. The difference between these two groups was whether the structure of the co-op (reflections,
reports, self-evaluations) or the role the administrator plays (site visits, facilitating the assignments) facilitated the learning more.

The breadth of Johnston et al.’s [26] study limits the claims that can be made as it relates to the student perspective. The authors looked at students from all types of institutions (2-year vs. 4-year, vocational vs. technical vs. research) and included co-op administrators, painting those participants (and the groups they discovered) with a broad brush. Additionally, they make many assumptions as to how the participants are interpreting the statements used in the study. For example, calling the last group “anti-co-op,” implies they were against the co-op system but further inspection of reported statement rankings seem to suggest not that the students are opposed to co-op but that they may view all related work experience with equal value. With the data that was collected by Johnston et al. [26], we are unable to determine what aspects of the co-op experience influenced this view.

Through this research, I sought to expand the work of Johnston, et al. [26] to more deeply document student perceptions of learning on co-op at a single institution in the United States. Specifically, the research question I sought to answer was: What are the different ways students perceive what and how they learned on co-op?
CHAPTER 2: BACKGROUND OF COOPERATIVE EDUCATION

This study investigated how students perceive their learning during their cooperative education experiences. To provide context for this study’s topic, Chapter 2 includes a brief history of cooperative education (co-op) programs, how co-op is defined relative to other work-integrated learning practices, and a discussion of previous work that explores the influence co-op has on student views and performance.

2.1 History of Co-op

The co-op program was developed at the turn of the 20th Century at the University of Cincinnati [14]. In 1906, Herman Schneider, Dean of the University of Cincinnati founded the co-op program to fulfill a growing need for specialized and practical work experience for engineering students [27], [28]. Schneider argued that there was a disconnect between material that was being taught in classes and what knowledge was needed in the field [14], [27], [28]. This original co-op program was structured to integrate practical work experiences by alternating between the two on a weekly basis (i.e. work one week, return to school the next week). Soon after the program was founded at the University of Cincinnati, other institutions followed suit: Northeastern in 1906, University of Detroit Mercy in 1911, Georgia Institute of Technology and Rochester Institute of Technology in 1912, among others in up through the 1920s, creating their own programs that were uniquely tied to their local industrial needs [14].

The number of co-op programs across the United States remained relatively stagnant until the passage of the Higher Education Act of 1965 [27]. Title VIII of the act
provided funds to support co-op programs and other work-integrated learning experiences for students which allowed many colleges and universities to establish programs. After the passage of the Higher Education Act of 1965, the number of co-op programs went from around 150 to their peak of 1,012 programs in 1986 [27]. Federal support for co-op programs was reduced in the 1980’s and disappeared in the 1990’s causing many co-op programs to shutter their doors.

In the early 2000’s until now, there has been an increased interest in co-op programs and the educational benefits that they can provide. This resurgence can be attributed to the increased interest by multiple stakeholders including students, companies, and institutional leaders [27], [29] centering around the strong desire for students to have an easy and smooth transition from their collegiate careers into their professional careers. Students may see the benefits that co-op provides (invaluable work experience, financial stability, etc.) to far outweigh its drawback of extended time to degree completion. While employers see great financial benefits to participating in co-op programs which can include increasing the quality of their recruits (i.e. train them on co-op for an anticipated full-time future job) and reduced training for students who transition into a full-time position, increased productivity at a reduced price, and increased visibility to the undergraduate body. Institutions are capitalizing on the marketing and retention value the co-op program can provide for them [27]. Institutions are motivated to build and foster the bridge between students and their industry partners because of the increased interest from both those parties.

Although the co-op experience has become a fixture at many institutions, especially institutions with strong engineering and technology programs, it is not often formally
incorporated into the curriculum and operates independently of academic departments. As such, there is limited oversight on documenting the learning that occurs on co-op. There is an associated body called the Cooperative Education and Internship Association (CEIA) which provides members tools to begin or improve co-op and formalized internship programs [14]. They also have an accreditation council which provides formal definitions of co-ops and internships as well as expectations for member programs. Although the accreditation body has developed guidelines and accreditation metrics, co-op programs are not required to be accredited.

2.2 Definition of Co-op

Work-integrated learning (WIL) is a term that is often used a catchall for programs or experiences that integrate work experiences into the academic curriculum [13], [30]. The goal of WIL is to provide real work experience to students and give them the opportunity to gain practical knowledge within their field. WIL can include such experiences as co-ops, practicums, project-based learning, service learning, clinical or professional placements, etc. What sets a co-op apart from these other types of WIL is its structure and cyclic nature of the experience. The CEIA defines a co-op as the structured method of combining classroom-based education with practical work experience… [which] provides academic credit for structured job experience. Co-op experiences are either full-time (40 hours per week) alternating periods (semester, quarter) of work and school or part-time (20 hours per week) combining work and school during the same time period. Co-op experiences are paid, supervised by a professional who has followed the same career path of the student and students complete more than one assignment (2 or more) with progressive levels of responsibility [14].

While co-ops tend to have multiple rotations dispersed throughout the curriculum, other WIL experiences like internships or practicums may only have a single experience associated with them [13], [30]. Additionally, practicums are designed to be completed near the end of the curriculum as a way for students to practice the skills they have developed within a discipline [13]. Also, typically, practicums are not paid and are designed to be relatively short. Unfortunately, it is often difficult to isolate a specific definition for each WIL experience as many researchers have noted that the terminology used to describe specific WIL experiences are heavily dependent on discipline, institution, and country [13], [30]. A practicum in an engineering discipline may have different expectations than a practicum in social work at the same institution. Additionally, engineering practicums in the United States may have different expectations as engineering practicums in Australia. To ensure transparency in this study, the definition that I will use for co-op is:

Co-op is a semester-long and structured experience where students earn academic credit for full-time, paid engineering work at a company. Students on co-op are assigned tasks that are authentic and representative of disciplinary expectations.

The remaining chapter will be a review of co-op research with specific sections that focus on different impacts the co-op experience has on students and industry including program development, academic outcomes, job-readiness, and learning.

2.3 Research about Co-op

Since co-op programs in the United States have existed for over 110 years, there is a breadth of knowledge that surrounds the co-op experience. Co-op research was supported by two main academic bodies: CEIA and the Cooperative and Experiential Education
Division (CEED, formerly known as the Cooperative Education Division) of the American Society of Engineering Education (ASEE) [14], [31]. Both bodies provided avenues for co-op administrators to publish their research on co-op and its impact on students. From 1964 to 2013 CEIA printed and distributed the Journal of Cooperative Education and Internships [14]. Articles in this journal, as well as CEED conference proceedings, were published by co-op administrators with their needs in mind. Many of these needs focused on providing evidence to rationalize the financial investment in co-op programs or on ways to improve the quality of co-op programs [27], [32]–[34].

2.3.1 Academic Outcomes of Co-op

Researchers in the co-op space have often focused at collecting enticing evidence to argue in support of co-op programs. Many large quantitative studies have explored the impact co-op has had on student performance in a multitude of ways. Lindenmeyer [17] compared co-op student progress with their non-co-op peers through an engineering degree. He compared various measures of academic performance (Quarterly GPA, percentage on probation, average number of classes failed a quarter, etc.) and retention rate, using SAT scores as a control variable. Students were split into a “Co-op” group and a “Non-Co-op” group. Students who co-oped consistently out-performed students who did not. Compared to their non-co-op peers, co-op students had a higher graduation GPA, were more likely to complete their engineering degree, and were less likely to be on probation or fail a class. Blair, Millea, and Hamme confirmed the GPA claims decades later while also controlling for race, gender, age, and ACT scores [18].

11
Exploring deeper into the impact co-op experiences have on academic performance, Noyes, Gordon, and Ludlum [16] concluded that students with co-op experience were more likely to perform better in their upper-level coursework. Controlling for prior GPA and number of co-op terms, Noyes et al. explored the impact co-op experiences could be having on individual course performance and were able to better tie it specifically to the co-op experience. They also explored which courses saw the greatest academic impact from having co-op experience. Courses with the largest “co-op effect” (higher academic performance for co-op students) were ones that emphasized and evaluated communication and teamwork skills more, for example, a senior design course or lab-based course.

2.3.2 Job Readiness due to Co-op

While many researchers have made an academic argument to validate co-op, others have explored how co-op positively contributes to the workforce. Students who have co-op experiences tend to have an easier time transition into full-time work [21]. Not only did employees self-report having an easier time transitioning to full-time work, but their supervisors agreed. Additionally, employees with previous co-op experience were more likely to gather information and learn the necessary skills to be successful at their job independently compared to their non-co-op peers. Supervisors reported that new employees without co-op experience were more likely to rely on formal training opportunities or proactive supervisors or coworkers [21].

Lastly, students who co-op have some financial benefits as well. In addition to documenting academic performance, Blair et al. [18] also documented the impact co-op experience had on starting salaries, noting that students who had completed the co-op
program had statistically higher starting salaries at their first full-time position. Additionally, students who are on co-op tend to earn wages that are approximately twice that of minimum wage. This provides students opportunities to build savings for financial support when they return to their studies.

2.3.3 Student learning on Co-op

With much of the co-op documentation focusing on programmatic assessment and developing fiscally responsible arguments for supporting a co-op program, little attention has been drawn on the actual learning experience for students. Many of the studies summarized in previous sections argue the value of the co-op whether it is through an efficient transition to full-time work or because of comparative academic success [35]. This evidence supports argument of the fiscal value of co-op to varied stakeholders (students, institutional leaders, corporate partners, and state and national legislators); however, less supportive to establishing the legitimacy of co-op as an impactful learning experience [27], [34], [36]

What little work that has been done on learning in co-op has mostly lacked systematic research, relying on anecdotal evidence or correlational support. Eames [37] described a case study of a chemistry students’ skill and identity development as he co-oped at a national lab. He found that building social relationships during the co-op experience positively impacted student identity, epistemology, and practical chemistry skills.

Johnston, Angerilli, and Gajdamaschko [26] were able to begin documenting perceptions of learning while on co-op by comparing viewpoints between students and co-
op administrators from British Columbian institutions. From their data, they found eight unique views of learning on co-op with a majority of students being represented by six views and practitioners being represented by two views. Student views on co-op fell under the categories described below.

1. **Co-op is for learning technical skills.** Participants in this group viewed co-op as the place in which to develop their discipline-specific technical skills. Learning on co-op happens due to the repetition of tasks and through trial and error. These skills were not taught in the classroom and could only be learned on the job.

2. **Co-op builds skills that enable students to be employable (professional skills).** This group saw co-op as the way to build teamwork and communication skills. They saw co-op as a place to build the skills necessary to navigate a workplace in general while the first group prioritized technical skill development. This group did not express *how* they thought they learned these skills, only that the skills were gained.

3. **Co-op is about learning and understanding the intended field.** This group went beyond the skill development described by Groups 1 and 2 and saw co-op as a place to learn and to become a part of the field in which they will work. They valued the learning process over learning outcomes and felt that they could apply school knowledge to the real-world on co-op. Like Group 2, there was not an expression of how learning occurred, only that it happened. Additionally, they viewed this learning as general and holistic. There was no evidence that specific skills or sets of knowledge were developed, just that learning occurred, and they felt more a part of the field with their co-op experience.
4. **Co-op is for the application of school-learned skills to the workplace.** While students learn all the necessary skills in school, they can apply those learned skills and knowledge while on co-op. Co-op students take the skills introduced in the classroom and can refine those skills in the workplace. Co-op helps deepen and refine knowledge learned at school. This group did not focus on overarching learning like Group 3, they saw co-op more as a place to refine abilities learned in school through more rigorous and consistent repetition. This view emphasized that knowledge was acquired in school and applied in co-op whereas Groups 1 & 2 implied their skills could only be developed on co-op and were not learned in school.

5. **Co-op complements the learning that happens in school.** This group does agree with Group 4 that knowledge learned in school is applied on co-op and can refine skills or understanding; however, they believe that different but overlapping material is learned in school and on co-op. The student benefits most from the combination of school and work because they expand their knowledge and understanding of material introduced in either context.

6. **Co-op provides no additional value over other related work experiences (anti-co-op).** This group of students did not believe that co-op provided any additional value over a related work experience. This group believes that learning occurs only in school and rarely occurs on the job. This group views any related work experience equal to co-op and does not believe the structure of a co-op program (reflections, job summary, self-assessments, etc.) provide any value.
2.4 Conclusions

The history of the co-op is storied and rich, going back over 110 years; however, the intent of the experience has not changed. At its core, co-op is an opportunity to build practical work experience in a structured and intentional manner. There a number of great outcomes of co-op including skill development, improved academic performance, and increased financial independence. However, much of the research focused on co-op has only focused on programmatic successes or student performance outcomes and not on the learning experiences of the students. There is great value in understanding the underlying learning processes that occur on co-op. In the next section, I will discuss the theoretical perspectives that I used for my research and the rationale on why these theories can provide insight into this space.
I have selected four theories to serve as theoretical perspectives for my research. As my research question explores what students believe they learned and how they learned it while participating in co-op, which can be a range of viewpoints (as seen in Johnston et al. [26]), multiple theories were used to provide a variety of perspectives for students to identify with or critique. While some students may view co-op as the way to develop self-management skills and build their abilities to become self-directed learners, others may see co-op as the place for them to synthesize their knowledge and build a deeper understanding of fundamental concepts discussed in their coursework or they may change their whole perspective on their role in the classroom and who is in control of knowledge. The range of these viewpoints requires that I allow my study to be guided by many theories that can be applied to the co-op experience. My study will be informed by Kolb’s Experiential Learning Theory, Lave & Wenger’s Situated Learning, Social Cognitive Career Theory, and Metacognition, which are described below. The first three theories are commonly used in the WIL literature. The fourth perspective, Metacognition, was selected based on findings from an early exploratory focus group. This exploratory focus group was held with co-op ambassadors who are students who have participated in the co-op program and return to meet with other students who are considering participating. Throughout this focus group, these students described how the co-op experience had impacted their metacognitive
practices and how those more developed metacognitive skills had a positive impact on their academic performance.

Chapter 5 will discuss how each theory influenced the development of the statements used for my study, connecting specific statements to the appropriate theories.

3.1 Kolb’s Experiential Learning Theory

Kolb’s experiential learning theory primarily grew from the work of John Dewey, Kurt Lewin, and Jean Piaget [38]. Kolb developed his Experiential Learning Theory (ELT) “to integrate the common themes in their work into a systematic framework that can address twenty-first century problems of learning and education” [38, p. xvii]. ELT specifically focuses on how experience within a space influences the development of knowledge and defines learning as “the process whereby knowledge is created through the transformation of experience” [38, p. 49]. Kolb’s framework has four steps in the learning process: **concrete experiences** lead individuals to make **observations and reflections**, from those observations and reflections, learners will **form abstract concepts and generalizations** which will inspire them to **test the implications** and from those tests, learners will gain additional **concrete experiences** and the cycle continues [38].

This type of learning often occurs while a student is on co-op and has often been used in co-op-related research [28]. On co-op, students interact with the environment around them, observing the ways in which their co-op industry functions. When completing a project, students typically are expected to explain (and in course reflect) on the observations they have made. From those reflections, students build generalizations and can test the implications in either a second project at their co-op or when they return to
their coursework. However, the lack of specificity in the theory limits how it can be used as a single unifying theory for the full study. Although ELT describes the how the learner uses observations to build knowledge, it does not consider the social interactions or the structure of the environment surrounding the learner, two key aspects of the co-op educational structure.

3.2 Lave & Wenger’s Situated Learning

While Kolb focused on the learner independent of the environment, Lave & Wenger posit that learning occurs through the social interactions of the learner with others in a community. As a person learns, they will become integrated into a community of practice [39]. An individual starts out on the edges of the community with limited knowledge and as they integrate into the community, they gain more responsibilities, skills, and applicable knowledge while also building an identity with the community. By participating in legitimate activities, individuals on the periphery begin their journey to becoming full members of the community.

At the beginning of a co-op, students begin on the periphery of the industry community with limited knowledge of the company, company language, or engineering in general. As they continue through their co-op, students become more integrated into the company, gaining knowledge about the company, the materials/products with which they work, and about what it means to be an engineer in this context. This framework successfully incorporates more specific areas of learning over ELT and incorporates identity development as an important facet of the learning experience; however, it does not fully represent the co-op experience. Students switch between being a student in the school
community and being a co-op in the industry community. The influence of one community of practice on another is not discussed in this framework. Students may consider school and industry as separate communities which is seen in Group 4 of Johnston et al. [26] or they could consider school and industry as facets of the same, but larger, engineering community.

3.3 Social Cognitive Career Theory

While ELT and Situated Learning are focused on how an individual learns and gains knowledge, social cognitive career theory [40], [41] focuses on how an individual chooses a career and reflects on personal factors that affect their career choices [40]. Social cognitive career theory (SCCT) “attempts to take a cognitive constructivist approach to career development” [40, p. 87] with both feedback and anticipatory ideals playing a role in the choices a person makes in reference to their career. Lent and colleges developed their model to describe how career decisions are made by focusing on the cycle that individuals experience over time when determining career interests. The model begins with sources of self-efficacy and outcome expectations. These sources drive an individual to evaluate their self on their abilities to pursue a career (self-efficacy) and what they anticipate the outcome of taking that career would be (outcome expectations). Those two then influence the individual’s interest in the career. That interest, along with their self-efficacy and outcome expectations, influence the goals and intentions they set in order to attain that career. After those goals/intentions are in place, the individual will then choose activities to practice. In participating in those activities, individuals will fulfill their set goals, build skills, and gain
feedback which are deemed performance attainments. Performance attainments become a new source of self-efficacy and outcome expectations which begins the cycle again.

In this study, SCCT provides insight into how students are confirming, refining, or revising their career choices based on their co-op experiences and how that is influencing their views of themselves or their field. When a student sets and meets those goals in their co-op (performance attainment), their self-efficacy in the classroom with problem sets, or in general as an engineer may increase. Additionally, co-op experiences can influence a student’s outcome expectations as they gain experience as an engineer. This framework explicitly discusses ways students may be using their co-op experiences to inform or influence their career decisions. Although knowledge about engineering and their future career goals can be gained, it is not the only knowledge that students may gain from their co-op experiences.

3.4 Metacognition

Metacognition was a term developed by Flavell in the late 1970s to describe the ways we think about thinking [42]. In his 1979 paper [42], Flavell describes four aspects of metacognition: metacognitive knowledge, metacognitive experiences, goals/tasks, and actions/strategies [42]. Metacognitive knowledge is “knowledge or beliefs about what factors or variables act and interact in what ways to affect the course and outcome of cognitive enterprises” [42, p. 907]. This includes what an individual knows about themselves or others, ideas about strategies that they may use in approaching a problem or what sources of knowledge to trust. Metacognitive experiences are the feelings that individuals have while processing knowledge. As Flavell describes it, metacognitive
experiences are the “conscious cognitive or affective experiences that accompany and pertain to any intellectual enterprise” [42, p. 906]. Metacognitive knowledge and experiences are interrelated and can affect each other. Metacognitive experiences can impact an individual’s cognitive goals, the strategies they use to meet those goals, or their metacognitive knowledge (either about the process or about themselves). Metacognition has been studied in a multitude of ways and contexts. Results of these studies tend to show that well-developed metacognitive skills and knowledge provide many academic benefits; however, more is to be understood about metacognition [43].

Instead of positing how learning can occur, metacognition is a skill that can be built both in the classroom and in the workplace, especially if that workplace fosters environments that reward metacognitive practices. Metacognition most closely connects to skill development described by the participants in the exploratory focus group briefly described at the beginning of this chapter but does not fully represent the breadth of learning experiences or skills developed by all co-op students.

3.5 Conclusion

Each of these theories relates to a different part of the co-op experience and can provide insight into the complexity of the co-op experience. Figure 3-1 depicts the relationships between each theory and how it relates to the co-op experience. Lave and Wenger’s Situated Learning and Kolb’s Experiential Learning Theory are learning theories that can be used to describe how the co-op student is learning through their experiences. These two theories are focused on how learning can occur through the co-op experience and have been utilized in prior co-op research.
Instead of describing the learning experience, Social Cognitive Career Theory is used to describe a student’s career trajectory, which is why it is located outside of the co-op experience. The concepts embedded in SCCT are heavily informed by the co-op experience but also are informed by informal and formal school and social experiences. While I embrace the influence of informal and formal school and social experiences on concepts in SCCT, the focus of this study will be on if and how the co-op experience contributes to concepts described in SCCT. Like SCCT, Metacognition is influenced by the co-op experience rather than a theory that specifically describes the co-op experience. Although formal school experiences can help develop metacognitive skills and practices, I posit that the co-op experience can be a stronger influence.

Figure 3-1: Figure that relates the four theoretical perspectives to each other and the co-op experience.
These theoretical perspectives were used to inform the development of statements related to learning on co-op while allowing students to determine what statements resonated most with them. These learning theories are common theories to apply to the context of co-op and have been used to guide research studies on co-op [20] or the development of assessment tools to measure learning outcomes for a co-op experience [28]. While each of the theories above has shortcomings, they also each potentially have something to add about how students learn on co-op.
CHAPTER 4: METHODOLOGY

This study used an embedded mixed methods design which collected, analyzed, and incorporated qualitative and quantitative data simultaneously. Creswell [44] defines mixed methods as

An approach to research in the social, behavior, and health sciences in which the investigator gathers both quantitative and qualitative data, integrates the two, and then draws interpretations based on combined strengths of both sets of data to understand research problems. (p. 2)

The purpose of mixed methods research is to integrate these two research paradigms which can provide a deeper and broader understanding of the research problem [44], [45]. Mixed methods research in social and behavioral studies has grown exponentially in the recent decades and is now seen as a method that is distinct from both quantitative and qualitative methods, with its own core concepts, terminology, and agreed upon expectations [44]–[46].

An embedded mixed methods design is one that collects and then analyzes both quantitative and qualitative data simultaneously. Embedded mixed methods designs also place an equal focus on the qualitative and quantitative strands of data and analysis whereas sequential mixed methods designs typically have a more dominate qualitative or quantitative arm [44]. A mixed methods approach was selected because of the value that both methods can provide in understanding learning on co-op. It is important to evaluate patterns and identify trends in the co-op learning space to help co-op programs build best practices that span across all the students they serve which is best served through
quantitative methods. However, there is power in the story and the additional context that qualitative methods provide. The integration of these two approaches allows the study to highlight how stories can transcend discipline, company, or personal interest which will best serve my varied audience.

The specific methodology selected was the Q-Methodology. The Q-methodology documents and categorizes complex areas that are difficult to measure including individual perceptions. Many authors of the Q-Methodology describe it as a systematic way to measure subjective spaces and use terms like *opinions, perspectives, viewpoints, worldviews, beliefs, or perceptions* to describe what it measures [26], [47]–[49]. Throughout a Q-Methodology study, the same data is represented and analyzed both qualitatively and quantitatively. Researchers have argued on where Q-Methodology lies on the quantitative to qualitative spectrum for years. While some treat the method as qualitative in nature [50], [51], as it studies perspectives and other subjective matters, others view it as a quantitative method because it relies on calculating correlations and determining factors [48], [50], [52], [53]. As the field of mixed methods has developed into its own space, researchers have embraced that Q-Methodology fits best within the mixed methods paradigm and aligns with the definitions developed by mixed methods researchers like Creswell, Tashakkori, Teddlie, Newman, Benz, and Ridenour [47] and describe this method as a “hybrid” or “inherently mixed” method. However, some researchers have argued that Q-Methodology transcends the label of a mixed methodology and have suggested calling it “qualiquantology” instead [54].
Q-Methodology has been used across many disciplines to document participant perceptions [48], [49] including limited work in STEM and specifically engineering education. In physics education, Ramlo and her colleagues have explored student epistemic beliefs in an introductory physics class [55], [56] while in engineering education, Kaifez and her colleagues explored how PhD students viewed the job search process [57]. Parallel to this dissertation, Desing has also leveraged the Q-Methodology in her dissertation exploring gender-based challenges that early career women engineering professionals face [58]. Other work within engineering education that have relied on the Q-Methodology include examining epistemic views of engineering among first year engineering students [59] and developing an instrument to evaluate co-curricular activities of undergraduate engineering students [4].

4.1 Q-Methodology and its steps

The Q-Methodology (or Q for short) was founded in 1935 by the researcher William Stephenson, who had PhDs in both physics and educational psychology [60]. He introduced the method through a letter to editor of Nature [50]. Q was developed to use the same statistical approach as exploratory factor analysis (EFA), but instead of grouping questions or items that are likely measuring the same construct, it groups individuals that likely have similar views [49].

In Q, researchers develop statements that are representative of the phenomenon of interest. These statements should be subjective, allowing the participant to interpret them and agree or disagree with their sentiments. This is intentional as Q embraces the fact that different participants will interpret the same statements in different ways. Once the
statements are developed, participants are asked to sort those statements into a quasi-normal distribution. Although the distribution shape does not affect the results of the analysis, it does help the participant better sort the statements and make choices [48], [61], [62]. McKeown and Thomas explain that the “recommended quasi-normal distribution is merely a device for encouraging subjects to consider the items more systematically than they otherwise might” [48, p. 34]. Although not required, a follow-up interview to explore the participant’s decision process and interpretation of statements is encouraged [63].

After all participants have completed the sorting exercise and recommended interview, the researcher assigns numerical scores to each statement based on their location within the distribution. To complete the quantitative analysis, the raw scores are combined into a matrix with the statements as the rows and the participants as columns. A correlation matrix for the participants is calculated and an exploratory factor analysis is performed on the correlation matrix. Participants meeting standard loading criteria are assigned membership to a specific factor. At the completion of the factor analysis, the researcher evaluates the factors to ensure they meet basic quantitative fit measures and then explore those factors qualitatively.

Qualitative exploration of Q typically consists of evaluating critical statements within a factor and, if applicable, the follow-up interview. These critical statements are ones that factor members have ranked extremely high or extremely low as well as statements that have statistically different scores relative to other factors, regardless of score. From that qualitative exploration of the statements, a description of that viewpoint is crafted by the researcher to represent the viewpoint of the factor.
4.2 Advantages of Q-Methodology

One of the biggest strengths of Q is that it can better differentiate participant viewpoints through the ranking and sorting process than a standard quantitative measure. In a traditional survey using a Likert-type scale, a participant can highly rank all the items, indicating that they agree with all the statements, but that does not help researchers identify what most closely represents the participant’s perception of an experience. One way to counter this behavior is to add negatively worded items, however, negatively worded items tend to not behave as predicted [64]. Additionally, having participants reflect on written statements can help them describe concepts that they have not thought about or tacit beliefs that they struggle to explain on their own. Q also provides a structure to the grouping process which can be more efficient than qualitative interviews, allowing more individuals to participate in the study and potentially more views to be documented. This methodological approach is ideal for my research question as it measures student views in a way that can appropriately differentiate between viewpoints in a systematic way. This differentiation allows me to document the varying ways students view and describe their co-op experience in an efficient and effective manner.

4.3 Differences Between Q and R

Although the factor analysis in Q is mathematically the same as exploratory factor analysis (EFA), there are some distinct differences in this research approach and the underlying assumptions that are made. In education research, EFA and similar statistical analyses are intended to be generalizable like creating an instrument that can be validated across many populations and be used to make general claims. Q is intended to systematically sort and group a sample that should be representative, but not exhaustive of
the whole population [47]–[49], [65]. These differences in intent drive much of the differences in methodological choices, recommendations for sample size, and the role of the researcher. The methodological choices before the factor analysis, how raw data is collected, the interpretation of the results after the factor analysis, and the conclusions that are made based on the results are what differentiate Q from R.

4.4 Terminology

Chapter 5 will discuss the specific details of this study; however, to ensure a clear understanding of those specifics, there are many terms that should be defined. *Q* or the *Q-methodology* are umbrella terms that refer to the overarching methodological approach used in this study which includes: the statement development, the card sorting activity, the interview, the assignment of scores, the quantitative data analysis, and the development of the factor profiles after analysis. The card sorting activity is referred to as a *Q-sort* while the quantitative analysis that occurs after all the Q sorts are collected is referred to as the *Q-factor analysis*. The results of the Q-factor analysis are the *factors* that represent unique viewpoints within the participant group. For each factor, a *profile* or description of the viewpoint is developed and described as a part of the results.
CHAPTER 5: RESEARCH DESIGN

In this chapter, I will discuss the specific details of this study and decisions that I made throughout the process (Figure 5-1). I will first talk about the statement development and how I created the phrases used in the sorting process. I will then talk about a pilot study and how its results shaped the final set of statements and the interview questions. Then I will talk about the data collection and data analysis. The results and discussion of the study will be shared in the following chapters.

Figure 5-1 Flowchart of the study showing the critical timepoints of development or analysis.

5.1 Statement Development

Initial statements related to learning on co-op were selected from Johnston et al. [26] and then modified to fit the context of this study. Modification of the statements were done to ensure that they fit the experiences of co-op students in the United States and focused on their views of learning. First, statements were changed from third person (“Through co-op students learn…”) to first person (“On co-op, I learned…”) to emphasize to the students their perspective was desired. In a study exploring student epistemologies,
Ramlo [56] determined that students were reporting socially acceptable physics or science epistemologies when statements were in third-person. When students were asked to sort statements written in the first-person, there was more variation within the data and, from follow-up interviews, those viewpoints were more representative of the students’ actual views.

Early in the statement development phase, it was apparent that skills that could be developed would need to be connected to ways those skills could be learned. Therefore, each statement had the same structure: “On co-op, I learned {what was learned} {how that learning occurred}.” The skills that could be learned were selected from Johnston et al.’s original publication [26] and identified as critical skills based on previous knowledge about and familiarity with the co-op program. When the skills were representative of specific theories used in this study, it was documented and used to determine if a specific theory was resonating the most with the participants. How those skills were developed were mapped to the theories relating to knowledge and learning as shown in Figure 5-2. Experiential Learning Theory, Situated Learning, and Social Cognitive Career Theory are all common theories used in co-op research while Metacognition was included based on results from an early exploratory focus group.
Table 5-1 shows the eleven skills and five learning processes that were used in the development of the statements. This was done to better identify what aspects of learning the students most identified with. Students may have felt they developed specific skillsets through a variety of avenues, or they may have felt they learned a variety of skills in a specific way. A total of 55 statements were used during the pilot study. For a full list of statements, see Appendix A: Mapping of Statement Phrases.
Table 5-1: Table of what was learned (skills) and how that learning could occur on co-op with skills. Learning statements that mapped to specific theories are noted in the secondary column.

<table>
<thead>
<tr>
<th>What was learned</th>
<th>Theory</th>
<th>How that learning occurred</th>
<th>Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>to work as part of a team</td>
<td></td>
<td>by watching the engineers in my company and doing what they do.</td>
<td>Situated Learning</td>
</tr>
<tr>
<td>to communicate effectively with others</td>
<td></td>
<td>by repeated practice in real-world situations on my team.</td>
<td>Experiential Learning Theory</td>
</tr>
<tr>
<td>to find and solve problems</td>
<td></td>
<td>when I reflected on my co-op experiences and thought about my learning.</td>
<td>Experiential Learning Theory</td>
</tr>
<tr>
<td>the technical skills of my discipline</td>
<td></td>
<td>from my own successes and failures.</td>
<td>Metacognition</td>
</tr>
<tr>
<td>about how I learn and how to learn from a variety of experiences</td>
<td>Metacognition</td>
<td>after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>Situated Learning</td>
</tr>
<tr>
<td>more about what I really want to do with my career</td>
<td>Social Cognitive Career Theory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>what to expect as an engineer</td>
<td>Social Cognitive Career Theory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>how much I don't know</td>
<td>Metacognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>who to connect with when I graduate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>how to manage conflicts or unexpected problems</td>
<td>Metacognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>new skills that will help me be successful in the workplace</td>
<td>Social Cognitive Career Theory</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.2 Pilot Study

A pilot study was employed to ensure that the Q-sort and interview would accurately represent student viewpoints and to ensure that the interview questions would be able to probe deeper into student views. Three students with co-op experience were invited to participate in the sorting process and evaluate the accuracy of the chosen statements. For their time, those students received a $15 Amazon Card. Students were asked to review the statements and select 40 of the 55 statements to sort into a quasi-normal distribution (Figure 5-3). This allowed me to explore what statements students were identifying with as well as statements that they felt were not representative of co-op in general. The pilot study also was used to evaluate the effectiveness of the interview protocol, and therefore students were asked the interview questions that were developed for the full study.

Figure 5-3: Visual of the quasi-normal distribution that was used for the pilot study.
During the first pilot, the student was first instructed to sort the 55 statements into four categories: (1) “Strongly agree/agree”, (2) “Strongly disagree/disagree”, (3) “Indifferent/neutral”, and (4) “Does not make sense or not representative of co-op”. In this pilot, I thought it was important to guide the student to developing the distribution because I felt sharing the distribution may confuse them or bias their response. After the statements were set into those four piles, I asked the student to pick out their top five statements and their bottom five statements and then I asked to explain their choices. From there I continued to ask for an additional set of statements for both the agree and disagree sides, guiding the student into building the desired quasi-normal distribution. Throughout the process, I asked questions to understand the participant’s reasoning for placing the cards where they were placed and for any examples from their co-op experience that explained that reasoning. At the conclusion of the interview, I asked the participant to critique the interview process and provide feedback on the delivery of the interview. The participant liked not being directed to create the distribution at the beginning, stating “because it really makes you pick a top [set of cards]. It wasn’t like I could agree with these later, I was like ‘No, I need to pick the big ones now.’”

Based on the positive response to the more directed sorting process, I followed the same general interview approach for the second pilot. I first instructed the participant to sort into the four piles (agree, disagree, neutral, nonsense) and then asked them to go through their agree pile to identify their top three statements. Instead of asking for their top five statements, I directed this participant to select their top three statements as that more accurately mapped to the desired distribution (Figure 5-3). The interview then continued
to guide the participant in building the agree side of the distribution, the disagree side of the distribution, and then the center column. At the completion of the interview, I again asked for commentary on how comfortable the interview process was. This participant expressed frustration that she did not know the goal distribution and it would have been easier for her to organize her thoughts if she knew of the distribution from the beginning.

After the second pilot, I reflected on which interview structure would be easier for both my participants and me and concluded that sharing the distribution at the beginning of the interview and asking the participants to complete the distribution on their own would be the better approach. For the third pilot, I structured the interview in this way and found it much easier to conduct and the participant did not express negative opinions of being asked to sort the cards all at once. This last pilot confirmed the interview structure of asking the participant to sort the full distribution and then interview them on their decision process.

After the three pilots were conducted, numerical scores were assigned to each of the cards that were sorted. Scores between +3 and -3 were assigned as shown in Figure 5-3 as well as the score -4 which was used to identify statements that the participant chose to omit from their distribution (Table 5-2). I reviewed the scores for each statement and the three pilots to determine which statements to keep for the full study. A statement was removed if received a -4 score from all three pilot participants. All other statements with at least one -4 score were considered for removal. Additionally, I removed all statements related to the “who to connect with when I graduate” phrase. As networking is not a skill that should consistently be integrated into the classroom, I decided it was not important to
measure in this study. A total of 13 statements were removed from the Q-set so 42 statements were included for the full study.

Additional pragmatic decisions on how to efficiently run the study were made based on my experience in the pilot study. Participants were given a stack of 3x5 cards that had one of the statements printed on them. To record the scores, I would attach a small sticky note onto the card with the numerical score on it. This was fine after the first pilot, but even by the third pilot, the sticky notes were falling off the card. To rectify this issue, I added a piece of packing tape on the back of the cards that acted like lamination and could use a dry erase marker to note the score for a participant, record that score into an Excel table, and then erase the score so that the card was blank for the next participant.

Because the statements were so similarly worded, finding each statement in the matrix by matching words was difficult. To add efficiency to the process, I numbered each card on the back so that I would have a way to organize the physical cards and the statements in my Excel sheet. The numbers were small and written in blue highlighter in one of the corners on the back of the card in an attempt to not draw attention to them during the sorting process (Figure 5-4). After scores were written on the cards and the Q-sort was photographically documented (pictures of the front and back of each card within the distribution were photographed for future reference), the cards would be collected and sorted in numerical order. The scores were then immediately entered into my Excel sheet. The added organization helped me quickly and efficiently enter and record data.
Table 5-2: Table of all the statements used in the pilot data and their corresponding scores for each participant. The Notes column indicates which statements were removed for the full study.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Pilot 1</th>
<th>Pilot 2</th>
<th>Pilot 3</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>-4</td>
<td>-4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences by repeated practice in real-world situations on my team.</td>
<td>-4</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences by watching the engineers in my company and doing what they do.</td>
<td>-1</td>
<td>-4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences from my own successes and failures.</td>
<td>-4</td>
<td>-4</td>
<td>-4</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned how much I don't know after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>0</td>
<td>-1</td>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned new skills that will help me be successful in the workplace when I reflected on my co-op experiences and thought about my learning.</td>
<td>-4</td>
<td>2</td>
<td>-4</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned how much I don't know by repeated practice in real-world situations on my team.</td>
<td>0</td>
<td>-2</td>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned how much I don't know from my own successes and failures.</td>
<td>-4</td>
<td>0</td>
<td>-4</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned how much I don't know by watching the engineers in my company and doing what they do.</td>
<td>0</td>
<td>-1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Experience</td>
<td>Rating 1</td>
<td>Rating 2</td>
<td>Rating 3</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned how much I don't know when I reflected on my co-op experiences and thought about my learning.</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned how to manage conflicts or unexpected problems after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>1</td>
<td>0</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned how to manage conflicts or unexpected problems by repeated practice in real-world situations on my team.</td>
<td>2</td>
<td>-4</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned how to manage conflicts or unexpected problems by watching the engineers in my company and doing what they do.</td>
<td>0</td>
<td>-2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned how to manage conflicts or unexpected problems from my own successes and failures.</td>
<td>-4</td>
<td>-4</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned how to manage conflicts or unexpected problems when I reflected on my co-op experiences and thought about my learning.</td>
<td>-4</td>
<td>-1</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned more about what I really want to do with my career after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>-4</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned more about what I really want to do with my career by repeated practice in real-world situations on my team.</td>
<td>1</td>
<td>0</td>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned more about what I really want to do with my career from my own successes and failures.</td>
<td>-4</td>
<td>-4</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned more about what I really want to do with my career by watching the engineers in my company and doing what they do.</td>
<td>3</td>
<td>-1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned more about what I really want to do with my career when I reflected on my co-op experiences and thought about my learning.</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned new skills that will help me be successful in the workplace after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned new skills that will help me be successful in the workplace by repeated practice in real-world situations on my team.</td>
<td>0 1 -4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned new skills that will help me be successful in the workplace by watching the engineers in my company and doing what they do.</td>
<td>0 2 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned new skills that will help me be successful in the workplace from my own successes and failures.</td>
<td>-4 -4 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned the technical skills of my discipline after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>-3 0 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned the technical skills of my discipline by repeated practice in real-world situations on my team.</td>
<td>-2 3 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned the technical skills of my discipline by watching the engineers in my company and doing what they do.</td>
<td>-3 -4 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned the technical skills of my discipline from my own successes and failures.</td>
<td>-3 1 -1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned the technical skills of my discipline when I reflected on my co-op experiences and thought about my learning.</td>
<td>-2 -3 -2 Removed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to communicate effectively with others after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>-4 3 -4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to communicate effectively with others by repeated practice in real-world situations on my team.</td>
<td>-4 1 -1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to communicate effectively with others by watching the engineers in my company and doing what they do.</td>
<td>-2 0 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to communicate effectively with others from my own successes and failures.</td>
<td>1 0 -3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to communicate effectively with others when I reflected on</td>
<td>-4 -4 0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
my co-op experiences and thought about my learning.

<table>
<thead>
<tr>
<th>Description</th>
<th>Rating</th>
<th>Improvement</th>
<th>Opacity</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>On co-op, I learned to find and solve problems after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>1</td>
<td>-4</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to find and solve problems by repeated practice in real-world situations on my team.</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned to find and solve problems by watching the engineers in my company and doing what they do.</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to find and solve problems from my own successes and failures.</td>
<td>-4</td>
<td>0</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to find and solve problems when I reflected on my co-op experiences and thought about my learning.</td>
<td>0</td>
<td>-2</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned the technical skills of my discipline by repeated practice in real-world situations on my team.</td>
<td>-2</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned the technical skills of my discipline by watching the engineers in my company and doing what they do.</td>
<td>-3</td>
<td>-4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned the technical skills of my discipline from my own successes and failures.</td>
<td>-3</td>
<td>1</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned the technical skills of my discipline when I reflected on my co-op experiences and thought about my learning.</td>
<td>-2</td>
<td>-3</td>
<td>-2</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned to communicate effectively with others after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>-4</td>
<td>3</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to communicate effectively with others by repeated practice in real-world situations on my team.</td>
<td>-4</td>
<td>1</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to communicate effectively with others by watching the engineers in my company and doing what they do.</td>
<td>-2</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to work as part of a team by repeated practice in real-world situations on my team.</td>
<td>-4</td>
<td>0</td>
<td>-4</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned to work as part of a team by watching the engineers in my company and doing what they do.</td>
<td>0</td>
<td>0</td>
<td>-4</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned to work as part of a team after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>-4</td>
<td>-4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to work as part of a team from my own successes and failures.</td>
<td>-2</td>
<td>-1</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned to work as part of a team when I reflected on my co-op experiences and thought about my learning.</td>
<td>-4</td>
<td>-3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned what to expect as an engineer after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned what to expect as an engineer by repeated practice in real-world situations on my team.</td>
<td>1</td>
<td>1</td>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned what to expect as an engineer by watching the engineers in my company and doing what they do.</td>
<td>3</td>
<td>-4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned what to expect as an engineer from my own successes and failures.</td>
<td>-2</td>
<td>-3</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned what to expect as an engineer when I reflected on my co-op experiences and thought about my learning.</td>
<td>1</td>
<td>-4</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>On co-op, I learned who to connect with when I graduate after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>-1</td>
<td>-4</td>
<td>1</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned who to connect with when I graduate by repeated practice in real-world situations on my team.</td>
<td>-1</td>
<td>-2</td>
<td>-1</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned who to connect with when I graduate by watching the engineers in my company and doing what they do.</td>
<td>-1</td>
<td>-4</td>
<td>0</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned who to connect with when I graduate from my own successes and failures.</td>
<td>-1</td>
<td>-2</td>
<td>-3</td>
<td>Removed</td>
</tr>
<tr>
<td>On co-op, I learned who to connect with when I graduate when I reflected on my co-op experiences and thought about my learning.</td>
<td>-2</td>
<td>-1</td>
<td>-3</td>
<td>Removed</td>
</tr>
</tbody>
</table>
5.3 Participant Selection and Recruitment in the Full Study

All students who participated in the study were from a single public land-grant institution located in the southeast United States and were registered for a co-op course in the Fall of 2018. An invitation to participate in this study was distributed to students by co-op administrators via email. The email invited students to complete a short qualification survey that asked their expectations prior to going on co-op, a short summary of their co-op duties, the number of rotations, their major, and the number of years they had been in school, and additional demographic information. For the invitation and complete survey, please see Appendix B: Email Invitation and Survey.

A total of 277 students were enrolled in a co-op course in the Fall of 2018, of those students 53 individuals participated in the initial qualification survey with 43 of those
students agreeing to being contacted for a follow-up interview. Table 5-3 shows the race and gender breakdown of the survey participants indicating an overwhelmingly White sample.

Table 5-3: Self-reported demographics of the students who participated in the survey.

<table>
<thead>
<tr>
<th>Race</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian or White</td>
<td>13</td>
<td>32</td>
<td>45</td>
</tr>
<tr>
<td>Caucasian or White &amp; Another race</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>South Asian</td>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>East Asian</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>African, African American, Black</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Not Reported</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>37</td>
<td>53</td>
</tr>
</tbody>
</table>

Students from a range of the above categories were invited to participate in the card sorting and interview with the express focus of inviting non-majority participants including students who represented different race, gender, or engineering major. The card sort and interview took approximately one hour to one hour and a half. For their time, students received a $25 Amazon card. Twenty-eight students participated in the interview with a range of backgrounds and co-op experiences. Table 5-4 provides the demographic information for each participant. Typical studies using the Q-method range from one participant to hundreds [47]. As Q is not intended to be an exhaustive representation of the whole population, a sample size of 28 is acceptable [47].
Table 5-4: Demographic information of each participant.

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Participant Pseudonym</th>
<th>Number of Rotations</th>
<th>Major</th>
<th>Gender</th>
<th>Race/Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Andy</td>
<td>3</td>
<td>Bioengineering</td>
<td>Female</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>2</td>
<td>Jules</td>
<td>4+</td>
<td>Industrial Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>3</td>
<td>Devin</td>
<td>2</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>4</td>
<td>Winter</td>
<td>1</td>
<td>Mechanical Engineering</td>
<td>Female</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>5</td>
<td>West</td>
<td>2</td>
<td>Civil Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>6</td>
<td>Corey</td>
<td>3</td>
<td>Industrial Engineering</td>
<td>Female</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>7</td>
<td>Rudy</td>
<td>1</td>
<td>Industrial Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>8</td>
<td>Dale</td>
<td>3</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>9</td>
<td>West</td>
<td>2</td>
<td>Industrial Engineering</td>
<td>Female</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>10</td>
<td>Charlie</td>
<td>1</td>
<td>Computer Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>11</td>
<td>Bobbie</td>
<td>2</td>
<td>Industrial Engineering</td>
<td>Female</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>12</td>
<td>Aspen</td>
<td>2</td>
<td>Computer Engineering</td>
<td>Male</td>
<td>Caucasian/White &amp; Other Asian</td>
</tr>
<tr>
<td>13</td>
<td>Ash</td>
<td>3</td>
<td>Computer Engineering</td>
<td>Male</td>
<td>South Asian</td>
</tr>
<tr>
<td>14</td>
<td>Adrian</td>
<td>1</td>
<td>Computer Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>15</td>
<td>Campbell</td>
<td>2</td>
<td>Civil Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>16</td>
<td>Ray</td>
<td>3</td>
<td>Industrial Engineering</td>
<td>Male</td>
<td>Did not identify</td>
</tr>
<tr>
<td>17</td>
<td>Julian</td>
<td>1</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>18</td>
<td>Jordan</td>
<td>3</td>
<td>Mechanical Engineering</td>
<td>Female</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>19</td>
<td>Drew</td>
<td>2</td>
<td>Chemical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td></td>
<td>Name</td>
<td>Age</td>
<td>Program</td>
<td>Gender</td>
<td>Ethnicity</td>
</tr>
<tr>
<td>---</td>
<td>-------</td>
<td>-----</td>
<td>--------------------------</td>
<td>--------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>20</td>
<td>Roan</td>
<td>3</td>
<td>Electrical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>21</td>
<td>Tyler</td>
<td>3</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>22</td>
<td>Chris</td>
<td>1</td>
<td>Industrial Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>23</td>
<td>Ryan</td>
<td>2</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>South Asian</td>
</tr>
<tr>
<td>24</td>
<td>Gray</td>
<td>2</td>
<td>Civil Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>25</td>
<td>Toby</td>
<td>1</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>26</td>
<td>Kaden</td>
<td>3</td>
<td>Industrial Engineering</td>
<td>Female</td>
<td>Caucasian/White &amp; Other Asian</td>
</tr>
<tr>
<td>27</td>
<td>Shawn</td>
<td>2</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
<tr>
<td>28</td>
<td>Blaine</td>
<td>1</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
</tr>
</tbody>
</table>
5.4 Q-sort and Interview

The Q-sort and interview data were collected during a single event. Participants were instructed to sort 42 statements into a quasi-normal distribution ranging from strongly agree to strongly disagree (Figure 5-5). After the participant completed the Q-sort, I conducted a follow-up semi-structured interview to better document the participant’s viewpoints and how they made their sorting choices. Participants were asked to provide a qualitative description of their strength of agreement (or disagreement) for each column, explanations of how they interpreted the statements and examples from their co-op that could expand their reasoning. Additionally, participants were asked if there were statements that were not representative of co-op in general as well as if there were parts of their co-op experience that were not represented by the statements (i.e. missing statements). For a full list of interview questions, see Appendix C: Interview Questions.
5.5 Quality and Legitimation Considerations

Throughout the study, I considered the quality of my work using two quality frameworks: Onwuegbuzie & Johnson’s legitimation framework for mixed methods research (Table 5-5) [66] and the Q³ quality framework (Qualifying Qualitative research Quality, Table 5-6) to guide research decisions [67], [68]. The legitimation framework was of most use in the intersections between quantitative analysis and qualitative analysis. Legitimation challenges the researcher to ensure that the data is integrated together to tell a more robust story. I recognize that the Q³ was developed for qualitative research, however, as the Q-Methodology focuses on the study of subjectivity, a quality framework
focused on interpretive analysis is valuable. The Q-methodology heavily relies on the participant’s interpretation of the statements during the Q-sort as well as the researcher’s interpretation of the results. Because of this, a framework that is designed for interpretive research can provide a structure to guide quality considerations. Both quality frameworks emphasize that quality cannot be an afterthought in a study; it must be considered throughout the study and during every research decision. Below are the ways in which I addressed quality in my study with notes as to which part of the frameworks they addressed.

Table 5-5: Definitions for Legitimation Framework.

<table>
<thead>
<tr>
<th>Sample Integration</th>
<th>How well the qualitative and quantitative data are combined and yield strong inferences.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside/ Outside</td>
<td>The degree to which the researcher accurately presents and utilizes the insider’s view and the observer’s view.</td>
</tr>
<tr>
<td>Paradigmatic Mixing</td>
<td>The ability of the researcher to mix competing epistemological, ontological, axiological, methodological, and rhetorical beliefs.</td>
</tr>
<tr>
<td>Commensurability</td>
<td>The ability of the researcher to switch between qualitative and quantitative lenses.</td>
</tr>
</tbody>
</table>
| Multiple Validities| The extent to which all relevant research strategies are utilized and research can be considered high on multiple relevant “validities”.
| Design Quality     | The standards used for the evaluation of the methodological rigor of the mixed methods research study. |
| Interpretive Rigor | The standards for evaluating the validity of the conclusions. |
One major quality consideration is how I operationalized the four theories into my study. The learning theories were integrated into the statement language used in the Q-sort where multiple statements were used to represent different dimensions of the theory (Q³ – Theoretical Validity). I also used the data from my pilot study to inform the statement language which helped the students identify with the statements (Q³ – Communicative Validity). Lastly, this research was designed to allow emergent results. With both the Q-methodology and the qualitative analysis, I have focused on understanding what emerges from the data and not *a priori* assumptions I have of what the data will reveal (Q³ – Theoretical Validity).

I recruited participants in a purposeful manner through the utilization of my initial survey which helped ensure that I gathered as wide range of viewpoints and experiences as

---

**Table 5-6 Definitions in Q³ Framework**

<table>
<thead>
<tr>
<th>Q³ Framework</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical Validity</td>
<td>Do the concepts and the relationships of the theory appropriately correspond to the social reality under investigation?</td>
</tr>
<tr>
<td>Procedural Validity</td>
<td>Which features of the research design improve the fit between the reality and the theory generated?</td>
</tr>
<tr>
<td>Communicative Validity</td>
<td>Is the knowledge socially constructed within the relevant communication community? Is the data gathering and knowledge produced representative of the participant’s voice?</td>
</tr>
<tr>
<td>Pragmatic Validity</td>
<td>Do the concepts and knowledge claims withstand exposure to the reality investigated? Are the concepts and claims compatible with the reality in the field?</td>
</tr>
<tr>
<td>Ethical Validity</td>
<td>What are the motives and intentions for investigating this social reality? How do those motives and intentions impact the data collection and analysis?</td>
</tr>
<tr>
<td>Process Reliability</td>
<td>How can the research process be made as independent as possible from random influences? Is data collected and analyzed in a dependable way?</td>
</tr>
</tbody>
</table>
possible (Q³ – Theoretical Validity) and allowing participants to challenge my assumptions (Q³ – Pragmatic Validity). To help challenge my assumptions, I selected some participants that expressed a less than positive opinion of their co-op experience in the qualification survey. This helped expand my understanding of the experience and ensure an opportunity to share their view. Q is designed to be an emergent methodology and does not have a strict guide to the number of groups that will develop from analysis. Q methodologists have provided suggestions for analysis but also emphasize the value of the dissenting opinion. McKeown and Thomas state “the importance of a factor cannot be determined by statistical criteria alone but must take into account the social and political setting to which the factor is organically connected” [48, p. 42]. Providing an incentive for the student was intended to help motivate students to participate in the study who may not otherwise, reducing the bias in my sample (Q³ – Theoretical Validity, Legitimation – Design quality).

Throughout data collection, I made many decisions to ensure that my interpretations are representative of the experiences of the participants and not my own co-op experience (Q³ – Procedural Validity, Legitimation – Design Quality). First, I maintained transparency by providing potential participants with as much information about the study as possible. During the recruitment portion, I explained the data collection process and how their identity in my study would remain protected (Q³ – Communicative Validity, Legitimation – Design Quality). During the data collection, I dressed casually to build rapport and ensure the participant felt at ease. Additionally, I emphasized that I am a graduate student and am not affiliated with the co-op office. This was to reassure the
participant that any material provided in the interviews would not have an impact on any continued participation in the co-op program (Q³ – Communicative Validity).

There is not a single correct way to sort the statements. Although statements were positively worded, they provided multiple avenues for learning the same thing. Additionally, the value of the sorting process stems from the relative position of the statements [49], [60], [62] and not the actual numerical score. Meaning that participants could disagree with more than half the statements without impacting the subsequent analysis. In my interviews, I asked participants to describe the scale and share their relative agreement or disagreement with the statements throughout the distribution, deepening my understanding of that participant’s view and their experience (Q³ – Communicative Validity, Legitimation – Interpretive Rigor). Lastly, my interview questions were designed to not indicate judgement and instead asked the participants to share their interpretation of the statements or asked for examples from their experience to clarify those interpretations (Q³ – Procedural Validity).

Additional quality considerations specific to the data analysis phase were also made. In the quantitative analysis, I used accepted cutoff values for number of factors which are described in multiple Q-Methodology guidebooks [47]–[49], [65] and evaluated five possible factoring solutions. Before constructing the profiles, I reflected on my own experiences with co-op which helped me acknowledge my own views, limiting their influence in my analysis (Q³ – Communicative Validity, Procedural Validity). During the qualitative phase, I used the statement language, the rankings within the factor, and
interview data to inform my development of the profiles (Q³ – Procedural Validity, Legitimation – Sample Integration, Commensurability).

Using the participant’s interpretation of the statements and the reasoning behind their sorting decisions not only allowed me to use student-centered language in my profiles but also ensured that the influence of my personal experiences with co-op was mitigated (Q³ – Procedural Validity, Communicative Validity). When present, I highlighted contradictory interview data to better construct the profile and share dissenting opinions within a factor. Highlighting contradictory data in my profiles helped to shore up my analysis and allow all student viewpoints within the group to be appropriately represented (Q³ – Procedural Validity, Theoretical Validity, Communicative Validity). Lastly, I shared summaries of my profiles to other co-op researchers and administrators at a conference to ensure they agreed with the findings (Q³ – Communicative Validity).

My whole study design also addresses some of the legitimation types described by Onwuegbuzie and Johnson [66]. The quantitative and qualitative arms of my study are highly related and heavily dependent on each other. This ensures strong sample integration and requires that I meet commensurability legitimation or that I can switch from between qualitative and quantitative lenses. Mixing the data as described in the Q-methodology requires that I move from subjective to objective in every step of the data analysis and process. For example, throughout the profile development stage, I used both the qualitative interviews and the quantitative score data (including both the individual Q-sorts and the representative factor sort). By considering all these dimensions of quality, I have also met the Multiple Validities Legitimation criterion which addresses the combination of the
validities that have been addressed and how well the “whole (i.e. meta-inference quality) [is] greater than the sum of its parts (i.e. inferences arising from each component)” [66, p. 59].
CHAPTER 6: DATA ANALYSIS

The data from the card sorting activity was analyzed quantitatively to identify groups of participants using the Q-methodology as described in Chapter 4. After participants were grouped, interview transcripts within each group were analyzed, identifying passages across the participants that were representative of the group views. Using both the interview data and the participants’ sorting results, these profiles were developed to describe each unique viewpoint. Participants who did not load onto any factor were then evaluated to determine if their views were qualitatively different from the any of the identified groups. Additional information (major, company size, number of rotations) was evaluated relative to the profiles to explore any influence on their views.

6.1 Q-factor Analysis

Quantitative data analysis was performed using R Statistical Software [69] and the “qmethod” package [70]. Each participant’s Q-sort was translated into quantitative scores by assigning a score from -3 to 3 for each statement based on its placement in the quasi-normal distribution (Figure 5-5). Raw sorting data was imported into R and the “qmethod” package was used to compute correlations between participants and determine multiple factoring solutions. The number of factors was decided through a high-level analysis of the factor sorts and numerical fit data, described in the next section. After selecting a four-factor solution, student interviews were coded and used to deepen my understanding of each factor.
6.1.1 Determining the Number of Factors

Like an exploratory factor analysis, determining the number of factors was an iterative process and relies on researcher interpretation to make a final decision. To determine the number of factors, I first looked for recommendations from the Q literature. There are a few resources that can be used to determine the number of factors and a collection of guidelines. Scholars have suggested that there should be about 4 to 6 participants per factor [51], which in this study ranges from 3 to 5 factors. Others suggest that seven factors tend to be sufficient for data analysis [60]. Another suggestion is to start with a large number of factors and then only allow factors that have two or more participants in them [51] as long as it is reasonable for the study data and participants. In some Q studies, having one participant in a factor is very meaningful [48] and therefore a single participant factor should be considered. One last suggestion is to ensure that the factors follow Humphrey’s rule which compares the cross-loading values of the solution with the standard error. If the cross-loading is larger than twice the standard error, the group is deemed a significant factor [60]. Although Humphrey’s rule is important to satisfy, it is the bare minimum for what is needed to make sure the factor is statistically different from the others [51]. These suggestions were considered, and multiple factoring solutions were computed to determine the appropriate number of factors. Researchers suggest that one should not rely on the quantitative results from the Q analysis alone [47], [48], [51], [54], [60]. Participant membership, the differentiating statements, and the “standard” sorting
results should be reviewed qualitatively to make a final determination on the number of factors [47], [48], [51], [54], [60].

From the guidelines discussed above, five Q factor solutions were evaluated ranging from a 3-Factor Solution to a 7-Factor Solution. Each factor solution was evaluated first to ensure that the solution satisfied Humphrey’s rule and then explored in more depth to make a final determination. Table 6-1 shows the number of participants per factor and the total number of participants that were factored in the solution. No factor solution successfully factored every participant meaning that at least one participant was not a member of any factor for any given solution. This is common in Q and can mean that the participant relates to multiple factors or has a unique perspective that is not held by other participants. Participants who were not factored were noted and were individually analyzed qualitatively.

Table 6-1: Summary of the number of participants in each factor and the total number of participants factored for each factoring solution evaluated.
After processing all the factoring solutions, I explored how each participant was represented in each solution. Table 6-2 shows the factor assignments for all participants across all solutions. As shown in Table 6-2, there were some participants that were often grouped with the same individuals; however, some participants seemed to be assigned to different factors depending on the number of factors in the solution. While participants 3, 5, 8, and 17 were always factored with each other, Participant 12 was assigned differently depending on the solution. This is likely because Participant 12 may have a more moderate viewpoint and could indicate their ability to agree with many groups.

Table 6-2: Factor assignments for each participant and factor solution. Participants are ordered by the 7-Factor solution assignment to better show how different participants are members of different groups depending on the number of factors. Note: a factor assignment of 0 indicates that the participant did not sort into any of the factors.

<table>
<thead>
<tr>
<th>Participant Number &amp; Pseudonym</th>
<th>7-Factor solution</th>
<th>6-Factor solution</th>
<th>5-Factor solution</th>
<th>4-Factor solution</th>
<th>3-Factor solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Andy</td>
<td>7</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>16 – Ray</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>27 – Shawn</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2 – Jules</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>14 – Adrian</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>21 – Tyler</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3 – Devin</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>5 – West</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>8 – Dale</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>17 – Julian</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>6 – Corey</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>7 – Rudy</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>11 – Bobbie</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>9 – Alex</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>15 – Campbell</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>25 – Toby</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
As recommended, I evaluated a standard sort for each factor within the solution which is a normalized sort across all participants within that factor. This factor sort is viewed as an idealized sort that represents what a central member of the group may provide during a Q-sort. This idealized sort shows the important values for the factor and can help identify differences between factors. Additionally, on the factor sort, I marked the differentiating statements for that factor. These differentiating statements are statements that have a statistically different score within the factor relative to the other factors in that solution. How a participant ranks these differentiating statements can be a good indicator of factor membership.

Other data that helped inform the factor selection process were notes that were taken during the interview. During the interview, I took notes on statements that the participant identified as impactful as well as a summary of their commentary about that statement. These notes then served as high-level summaries of the participant’s views which then could be compared to other members of the factor to determine whether that factor solution might be appropriate.
6.1.2 Comparing Factor Solutions

The first factor solution I evaluated was a 7-factor solution because, according to the Q-Methodology factoring guidelines, that should be the maximum number of factors for my data. The 7-factor solution included one factor with just one participant: Factor 6 with Participant 2. Typically, a single participant factor indicates a person with a role that is unique relative to the remaining sample, for example, the attending physician on medical floor relative to the nurses and aids [48]. As this population includes engineering students who all participated in co-op at a specific time, I did not anticipate a wholly unique viewpoint and therefore critically analyzed that participant’s sorting data and determined that the participant did not have a view that was qualitatively unique relative to all other participants. Therefore, the 7-Factor solution was omitted as a viable option.

The 6-factor solution was then evaluated to determine its viability. When comparing the representative sort data with the interview notes, there were qualitative conflicts. Some of the factors only contained two participants that had dramatically different Q-sorts. When reviewing interview notes, there were conflicts on statement interpretation and what statements were critical to the participant. Specifically, I compared the representative sort to the individual sorts from each participant. I focused on the statements that were in the +3 and -3 category as those were the most important statements to the participants. When comparing the representative sort with the participant’s individual sorts, alignment was limited. Because of this, the 6-factor solution was omitted from analysis.
The 3-factor solution was then considered. Similar to the 6-factor solution, I reviewed the representative sort data and documented that many of the statements in the +3 and -3 categories in the representative sort were not in the +3 and -3 categories for any of the participant sorts. This seemed to indicate that there were too many participants in each factor and that differing views were being diluted in the representative data.

This left two solutions: the 4-factor solution and the 5-factor solution. When reviewing the representative sorts between these two solutions, there were limited differences and the extra factor in the 5-factor solution was not obviously different. Because these two solutions seemed similar, I then evaluated which participants were members of each of the factors (Table 6-2). There was strong alignment between factor membership with exact agreement for one of the factors (i.e. Factor 4 was the same for each solution) and there was strong agreement for three other factors with the only difference between solutions was that there were one to three more members in each factor for the 4-factor solution. The major difference was placement of the two participants in Factor 5 of the 5-factor solution. In the 4-factor solution, one of those participants was grouped into Factor 1 and the other participant remained ungrouped. As there were only minor membership differences between these two factor solutions, slightly larger groups, and fewer unfactored participants in the 4-factor solution, I decided to qualitatively explore the 4-factor solution.

6.2 Qualitative Analysis

Once the groups were quantitatively established, I analyzed the interview transcripts for each factor to expand and deepen my understanding of each factor. Emergent
qualitative coding was conducted using Dedoose software [71]. Participant transcripts for a single factor were isolated and coded around the same time. Transcripts were open coded allowing the themes and the participant narrative to emerge from the data. The first step in coding was to familiarize myself with the participant and their voice by listening to their interview while reading their transcript. This helped me hear their voice when coding and gave me a general understanding of their tone, attitude, and experience so I did not get lost in the details while coding. Emergent coding of the transcripts allowed the participant’s voice to remain central to the data development. While open coding was employed, I also reflected on my own positionality, and applied memos to code applications as I felt necessary. A unique characteristic of the Dedoose software is the ability to apply memos at multiple levels, including code applications. I used this capability to help document any additional commentary or reasoning in applying the code. At the completion of coding all the transcripts in a factor, I would review all codes and memos of that factor and begin constructing the factor profile.

6.3 Factor Profile Development

After open coding was conducted for all the participants within the factor, I developed a factor profile by integrating the quantitative and qualitative strands of data and analysis. First, I listened to all the participant interviews, one right after another. Listening to all the participants in the factor so close to each other allowed me to better connect the narratives across the entire factor. Then I reviewed each participant’s final card sort and compared it to the representative factor sort. I did this by noting the score difference between the cards in the participant sort and where its location in the representative factor...
sort. This quantitative comparison helped me identify how aligned the participant’s sort was to the representative factor sort and where there were deviations from the factor sort.

From here, I began developing a general description of the profile through the development of a structured memo. Structured memos are a tool for researchers to systematically document information and can improve future cross-case analysis [72]. The intent of these structured memos was to provide context of who was in the factor, what their roles and general responsibilities were on their co-op, and identify similarities and differences in their views relative to the others who were also in the factor. The first part of the structured memo included demographic information for each participant, a description of their roles and responsibilities on their co-op and, the representative sort data for the factor. This was used to help situate the narratives and provide context to quotes that were in the second part of the memo. The second part of the memo included similarities and differences of the participant views, including evidence from each of the participant’s transcript, where applicable. The third part of the memo documented any connections that the factor or participants within the factor had with others outside their factor. This third part of the memo helped begin the cross-case analysis and document my initial understanding of the factor or specific participants in relation to those outside the factor while the information was fresh in my mind. This section was less structured than the others and could either have a lot or a little, depending on the factor profile and the participants within it.
Chapter 4 introduced the Q-Methodology, Chapter 5 discussed the research design and the development of the research project, and Chapter 6 discussed the data analysis and rationale for selecting the 4-Factor solution. In this chapter, I will discuss the results of the factor analysis with specific focus on the development of the profiles for each factor.

7.1 Summary of Factors

As explained in Chapter 6, the 4-Factor solution was determined to be the most viable solution for this data set. Based on my full analysis, I named the four factors as (1) The Problem Solvers, (2) The Apprentices, (3) The Doers, and (4) The Deciders. Details on how each participant was assigned their factor and the analysis that lead to these descriptive names are described in detail below. Prior to exploring the interview data, I named each factor based on their representative Q-sorts exploring the statements that were ranked very high and very low. I used this to get a holistic view of the factor views and to help focus my attention while coding. After coding all the transcripts in the factor, I reviewed the initial name and determined if it was an accurate description of the view. Of the four factors, the only factor that changed names was “The Apprentices”. Initially, the group was named “The Team Players” but upon qualitative review, I changed the name to “The Apprentices”. The reasoning behind this change is discussed in the section titled: 7.2.2 Factor 2: The Apprentices.
Overall, role and daily responsibility significantly influenced the participant views; however, students with similar roles did factor into different groups. This influence is to be expected as both Experiential Learning Theory and Situated Learning imply that learning is based on what an individual is exposed to and how they interact with their environment. Many of the participants in this study had positive feelings towards their co-op experience; however, those students who expressed dissatisfaction with their co-op still recommended that other students participate in co-op. These students felt that by going on co-op and finding out what they did not enjoy was just as useful, if not more, than finding out what they do enjoy.

Many of the students expressed more of an agreement with the statements than a disagreement, feeling their true “neutral” was located a column or two to the right of center (recall Figure 5-5). Some participants also described they agreed with their top three statements (in the “Strongly Agree” column) significantly more than they disagreed with their bottom three statements (in the “Strongly Disagree” column). This indicates that these statements were resonating with the students and that they saw their co-op experiences as an impactful learning experience. Although some students felt the quasi-normal distribution was an accurate portrayal of their views (i.e. an equal number of statements they agreed and disagreed with), no student disagreed with more statements than agreed with them.

Additionally, participants tended to disagree with statements ended with “when I reflected and thought about my learning.” In the interviews, they would state that they were not “a reflective person” or “don’t do that sort of thing.” However, during the interview,
they would talk about looking back at an earlier time on co-op or thinking and mulling over an issue they were trying to address. Students did not describe this behavior as reflection most likely because of their interpretation of the word. This interpretation is likely related to the connotation that these participants have of the word “reflection” as they tend to see it as a “structured and formal way to think back and reflect on the whole experience.”

*I don't know if that's simply a wording or when it talks about "reflected on my co-op experience and thought about my learning." I put that a lot of those in the disagree just because I felt like a lot of them happen in the moment, and what I was thinking when it said "reflected on my experience" is after co-op completely and go back and look at the experiences. But with the wording it could have also meant looking back at the situation from maybe a day later, still during the co-op. So that might've made me put it in the agree pile, I would think if I had thought about it that way. So maybe, yeah. So if it said something about being in... I guess the word reflecting just made me think it was after the co-op experience completely, which is maybe the intention, but if it was during the co-op experience, then I probably would've said agree because I would definitely think about things that had happened. But once it was months later, it didn't help me that much to reflect on it.*

(Kaden)

Kaden, and many of the other participants, interpreted the reflection statement as going back and thinking about all their co-op experiences after they returned to their coursework and not the less formal process of thinking and processing their experience on a more
immediate timescale. As students did not attribute learning much from that type of reflection, they often disagreed with those statements during the sorting process.

### 7.1.1 Evaluating the Factors

After the 4-Factor solution was selected, participant membership within each factor was explored. Participants were automatically flagged by the qmethod algorithm for membership into a single factor if their loading onto the factor was statistically high [60]. Meaning, for a significance threshold of \( p < 0.05 \), loading on the factor, \( l \), should satisfy the equation below with \( N \) being the number of statements in the Q-sort.

\[
l > \frac{1.96}{\sqrt{N}}
\]

For this study, with a total of 42 statements, the minimum statistically significant factor loading is 0.302. Table 7-1 contains the factor loadings for all participants in the study. The larger the factor loading, the closer the participant was to the ‘center’ of the factor. If a participant had loadings on multiple factors that exceeded the minimum factor loading and were relatively similar in value, they were not included in the factor and were considered “ungrouped”. After factor profiles were developed, factor membership for the ungrouped participants was evaluated using their factor loadings and interview responses as guidance.
Table 7-1: Factor loadings for all of the participants. Loadings that are dark and bolded indicate a statistically significantly loading for that factor.

<table>
<thead>
<tr>
<th>Participant Number &amp; Pseudonym</th>
<th>Factor 1 Problem Solvers</th>
<th>Factor 2 Apprentices</th>
<th>Factor 3 Doers</th>
<th>Factor 4 Deciders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Andy</td>
<td>0.491</td>
<td>0.370</td>
<td>-0.239</td>
<td>-0.314</td>
</tr>
<tr>
<td>2 – Jules</td>
<td>0.051</td>
<td>0.090</td>
<td>0.764</td>
<td>-0.018</td>
</tr>
<tr>
<td>3 – Devin</td>
<td>-0.207</td>
<td>0.103</td>
<td>-0.104</td>
<td><strong>0.703</strong></td>
</tr>
<tr>
<td>4 – Winter</td>
<td>0.210</td>
<td><strong>0.479</strong></td>
<td>0.006</td>
<td>0.393</td>
</tr>
<tr>
<td>5 – West</td>
<td>0.084</td>
<td>0.363</td>
<td>0.043</td>
<td><strong>0.535</strong></td>
</tr>
<tr>
<td>6 – Corey</td>
<td>0.138</td>
<td>0.017</td>
<td><strong>0.807</strong></td>
<td>-0.161</td>
</tr>
<tr>
<td>7 – Rudy</td>
<td>0.228</td>
<td>0.434</td>
<td>0.420</td>
<td>-0.126</td>
</tr>
<tr>
<td>8 – Dale</td>
<td>0.309</td>
<td>-0.073</td>
<td>0.027</td>
<td><strong>0.644</strong></td>
</tr>
<tr>
<td>9 – Alex</td>
<td>0.135</td>
<td><strong>0.675</strong></td>
<td>0.294</td>
<td>-0.227</td>
</tr>
<tr>
<td>10 – Charlie</td>
<td><strong>0.688</strong></td>
<td>0.075</td>
<td>0.108</td>
<td>0.219</td>
</tr>
<tr>
<td>11 – Bobbie</td>
<td>0.254</td>
<td>0.169</td>
<td><strong>0.601</strong></td>
<td>0.352</td>
</tr>
<tr>
<td>12 – Aspen</td>
<td><strong>0.573</strong></td>
<td>0.455</td>
<td>-0.148</td>
<td>-0.076</td>
</tr>
<tr>
<td>13 – Ash</td>
<td><strong>0.648</strong></td>
<td>0.085</td>
<td>-0.013</td>
<td>0.177</td>
</tr>
<tr>
<td>14 – Adrian</td>
<td><strong>0.589</strong></td>
<td>-0.503</td>
<td>0.175</td>
<td>0.175</td>
</tr>
<tr>
<td>15 – Campbell</td>
<td>0.382</td>
<td><strong>0.569</strong></td>
<td>0.349</td>
<td>-0.112</td>
</tr>
<tr>
<td>16 – Ray</td>
<td>-0.062</td>
<td>0.245</td>
<td>0.350</td>
<td>0.261</td>
</tr>
<tr>
<td>17 – Julian</td>
<td>0.279</td>
<td>-0.185</td>
<td>-0.014</td>
<td><strong>0.696</strong></td>
</tr>
<tr>
<td>18 – Jordan</td>
<td>0.291</td>
<td>0.390</td>
<td>0.270</td>
<td>0.161</td>
</tr>
<tr>
<td>19 – Drew</td>
<td><strong>0.644</strong></td>
<td>0.003</td>
<td>0.472</td>
<td>-0.099</td>
</tr>
<tr>
<td>20 – Roan</td>
<td><strong>0.615</strong></td>
<td>0.246</td>
<td>0.157</td>
<td>0.137</td>
</tr>
<tr>
<td>21 – Tyler</td>
<td>-0.114</td>
<td><strong>0.808</strong></td>
<td>-0.084</td>
<td>0.135</td>
</tr>
<tr>
<td>22 – Chris</td>
<td><strong>0.647</strong></td>
<td>0.153</td>
<td>0.369</td>
<td>0.318</td>
</tr>
<tr>
<td>23 – Ryan</td>
<td>0.453</td>
<td>0.427</td>
<td>0.256</td>
<td>0.387</td>
</tr>
<tr>
<td>24 – Gray</td>
<td><strong>0.588</strong></td>
<td>0.008</td>
<td>0.480</td>
<td>0.052</td>
</tr>
<tr>
<td>25 – Toby</td>
<td><strong>0.604</strong></td>
<td>0.242</td>
<td>0.248</td>
<td>-0.098</td>
</tr>
<tr>
<td>26 – Kaden</td>
<td>0.121</td>
<td><strong>0.486</strong></td>
<td>0.169</td>
<td>0.051</td>
</tr>
<tr>
<td>27 – Shawn</td>
<td>0.210</td>
<td><strong>0.467</strong></td>
<td>0.250</td>
<td>0.284</td>
</tr>
<tr>
<td>28 – Blaine</td>
<td>0.388</td>
<td>0.411</td>
<td>-0.163</td>
<td>0.188</td>
</tr>
</tbody>
</table>

After the factor loadings were evaluated and membership was determined, a representative Q-sort for the factor was constructed. This was done by calculating a weighted z-score for each statement using the factor loadings as weights and the statement
z-scores for each participant within that factor. Consensus and distinguishing statements were then determined by calculating the differences in z-scores of each statement between factors. In the software, the weighted z-scores for each factor are compared for each statement and the p-value is determined (Table 7-2). The first column in the is the statement number, the second column identifies which statements distinguish which factors. For example, statements 8, 15, and 33 distinguish Factor 1, but do not distinguish Factors 2, 3, or 4 from each other, whereas statements 1, 4, and 7 distinguish Factors 1 and 3, but not Factors 2 and 4. Consensus statements are statements that do not have any differences at a significance level of p<0.05. The remaining columns report the absolute differences between the two reported factors (for example, f1_f2 indicates the difference between the Factor 1 weighted z-score and the Factor 2 weighted z-score) with their respective significance indicators immediately after the reported value.
Table 7-2: Table of all distinguishing and consensus statements for this study. Number of * indicates significance level
(* p<0.05, ** p<0.01, *** p<0.001, **** p=0.000).

<table>
<thead>
<tr>
<th>Statement Number</th>
<th>Distinguishing &amp; Consensus Notes</th>
<th>f1_f2</th>
<th>f1_f3</th>
<th>f1_f4</th>
<th>f2_f3</th>
<th>f2_f4</th>
<th>f3_f4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Distinguishes f1 Distinguishes f3</td>
<td>0.658*</td>
<td>-0.735*</td>
<td>0.914**</td>
<td>-1.393***</td>
<td>0.256</td>
<td>1.649***</td>
</tr>
<tr>
<td>2</td>
<td>Distinguishes f3</td>
<td>0.749**</td>
<td>-0.824*</td>
<td>0.438</td>
<td>-1.573***</td>
<td>-0.311</td>
<td>1.263***</td>
</tr>
<tr>
<td>3</td>
<td>Distinguishes f3 Distinguishes f4</td>
<td>-0.306</td>
<td>1.040**</td>
<td>-1.805****</td>
<td>1.346***</td>
<td>-1.499****</td>
<td>-2.845****</td>
</tr>
<tr>
<td>4</td>
<td>Distinguishes f1 Distinguishes f3</td>
<td>0.690**</td>
<td>-1.155***</td>
<td>0.592*</td>
<td>-1.844****</td>
<td>-0.098</td>
<td>1.746***</td>
</tr>
<tr>
<td>5</td>
<td>Distinguishes f2 Distinguishes f3</td>
<td>1.820****</td>
<td>2.946****</td>
<td>-0.411</td>
<td>1.126***</td>
<td>-2.231****</td>
<td>-3.357****</td>
</tr>
<tr>
<td>6</td>
<td>Distinguishes f1 Distinguishes f4</td>
<td>0.557*</td>
<td>0.798*</td>
<td>-1.854****</td>
<td>0.241</td>
<td>-2.411****</td>
<td>-2.652****</td>
</tr>
<tr>
<td>7</td>
<td>Distinguishes f1 Distinguishes f3</td>
<td>-1.018***</td>
<td>1.297***</td>
<td>-1.222***</td>
<td>2.315****</td>
<td>-0.204</td>
<td>-2.520****</td>
</tr>
<tr>
<td>8</td>
<td>Distinguishes f1</td>
<td>1.212***</td>
<td>1.636****</td>
<td>1.374***</td>
<td>0.424</td>
<td>0.162</td>
<td>-0.262</td>
</tr>
<tr>
<td>9</td>
<td>Distinguishes f2 Distinguishes f4</td>
<td>1.365****</td>
<td>0.257</td>
<td>2.225****</td>
<td>-1.109**</td>
<td>0.860**</td>
<td>1.968****</td>
</tr>
<tr>
<td>10</td>
<td>Distinguishes f2 Distinguishes f3</td>
<td>0.857***</td>
<td>-0.880**</td>
<td>0.162</td>
<td>-1.737****</td>
<td>-0.695*</td>
<td>1.043**</td>
</tr>
<tr>
<td>11</td>
<td>Distinguishes f1 Distinguishes f2</td>
<td>-2.534****</td>
<td>-1.122***</td>
<td>-1.836****</td>
<td>1.412***</td>
<td>0.698*</td>
<td>-0.714</td>
</tr>
<tr>
<td>12</td>
<td>Distinguishes f2</td>
<td>2.289****</td>
<td>-0.537</td>
<td>0.482</td>
<td>-2.826****</td>
<td>-1.807****</td>
<td>1.019**</td>
</tr>
<tr>
<td>13</td>
<td>Distinguishes f3</td>
<td>0.566*</td>
<td>-0.650*</td>
<td>0.536</td>
<td>-1.216***</td>
<td>-0.030</td>
<td>1.186**</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>0.495</td>
<td>-0.942**</td>
<td>-0.897**</td>
<td>-1.437****</td>
<td>-1.392***</td>
<td>0.045</td>
</tr>
<tr>
<td>15</td>
<td>Distinguishes f1</td>
<td>-0.548*</td>
<td>-0.798*</td>
<td>-1.039***</td>
<td>-0.250</td>
<td>-0.491</td>
<td>-0.241</td>
</tr>
<tr>
<td>16</td>
<td>Distinguishes f1 Distinguishes f4</td>
<td>-1.211***</td>
<td>-1.356***</td>
<td>-2.367****</td>
<td>-0.145</td>
<td>-1.155***</td>
<td>-1.010**</td>
</tr>
<tr>
<td>17</td>
<td>Distinguishes f3 Distinguishes f4</td>
<td>0.411</td>
<td>-1.211***</td>
<td>-2.348****</td>
<td>-1.622***</td>
<td>-2.759****</td>
<td>-1.137**</td>
</tr>
<tr>
<td></td>
<td>Distinguishes f1</td>
<td>Distinguishes f2</td>
<td>Distinguishes f3</td>
<td>Distinguishes f4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
<td>----------------</td>
<td>----------------</td>
<td>----------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>1.415****</td>
<td>0.816*</td>
<td>2.432****</td>
<td>-0.599</td>
<td>1.017**</td>
<td>1.616***</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>-0.048</td>
<td>-0.359</td>
<td>1.216***</td>
<td>-0.311</td>
<td>1.264***</td>
<td>1.575***</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>-1.700****</td>
<td>-0.267</td>
<td>1.091***</td>
<td>1.432***</td>
<td>2.791****</td>
<td>1.359***</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>0.006</td>
<td>0.311</td>
<td>1.379***</td>
<td>0.305</td>
<td>1.373***</td>
<td>1.068**</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>1.152***</td>
<td>0.619</td>
<td>0.868*</td>
<td>-0.533</td>
<td>-0.284</td>
<td>0.249</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>1.113***</td>
<td>1.033**</td>
<td>-0.299</td>
<td>-0.079</td>
<td>-1.412***</td>
<td>-1.332***</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>-1.450****</td>
<td>0.012</td>
<td>-0.805**</td>
<td>1.462***</td>
<td>0.645*</td>
<td>-0.817*</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>0.811**</td>
<td>1.723****</td>
<td>-0.445</td>
<td>0.912**</td>
<td>-1.257***</td>
<td>-2.169****</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>0.790**</td>
<td>0.669*</td>
<td>1.429****</td>
<td>-0.120</td>
<td>0.639*</td>
<td>0.760*</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>-1.290****</td>
<td>-0.945**</td>
<td>0.824**</td>
<td>0.346</td>
<td>2.114****</td>
<td>1.769****</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>-1.668****</td>
<td>-1.440***</td>
<td>0.137</td>
<td>0.229</td>
<td>1.805****</td>
<td>1.576***</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Consensus</td>
<td>-0.216</td>
<td>-0.152</td>
<td>-0.475</td>
<td>0.064</td>
<td>-0.259</td>
<td>-0.323</td>
</tr>
<tr>
<td>30</td>
<td>Distinguishes f3</td>
<td>-0.255</td>
<td>-1.006**</td>
<td>-0.215</td>
<td>-0.751*</td>
<td>0.040</td>
<td>0.791*</td>
</tr>
<tr>
<td>31</td>
<td>Distinguishes f1</td>
<td>0.640*</td>
<td>1.876****</td>
<td>1.552****</td>
<td>1.235***</td>
<td>0.911**</td>
<td>-0.324</td>
</tr>
<tr>
<td>32</td>
<td>Distinguishes f2</td>
<td>-2.626****</td>
<td>-0.556</td>
<td>-1.074***</td>
<td>2.070****</td>
<td>1.552***</td>
<td>-0.518</td>
</tr>
<tr>
<td>33</td>
<td>Distinguishes f1</td>
<td>1.277****</td>
<td>2.215****</td>
<td>1.652****</td>
<td>0.938**</td>
<td>0.375</td>
<td>-0.563</td>
</tr>
<tr>
<td>34</td>
<td>Consensus</td>
<td>-0.364</td>
<td>0.175</td>
<td>0.200</td>
<td>0.539</td>
<td>0.563</td>
<td>0.025</td>
</tr>
<tr>
<td>35</td>
<td>Distinguishes f2</td>
<td>-1.533****</td>
<td>-0.310</td>
<td>1.614****</td>
<td>1.223***</td>
<td>3.147****</td>
<td>1.924****</td>
</tr>
<tr>
<td>36</td>
<td>-0.599*</td>
<td>-0.598</td>
<td>-0.181</td>
<td>0.001</td>
<td>0.418</td>
<td>0.417</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>-0.232</td>
<td>-1.333***</td>
<td>-1.183***</td>
<td>-1.102**</td>
<td>-0.951**</td>
<td>0.150</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>-0.016</td>
<td>0.718*</td>
<td>0.096</td>
<td>0.734*</td>
<td>0.112</td>
<td>-0.622</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>-0.163</td>
<td>-0.804*</td>
<td>-1.075***</td>
<td>-0.641</td>
<td>-0.912**</td>
<td>-0.271</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Distinguishes f2</td>
<td>-2.115****</td>
<td>0.505</td>
<td>-0.922**</td>
<td>2.620****</td>
<td>1.192***</td>
<td>-1.427****</td>
</tr>
<tr>
<td>41</td>
<td>Consensus</td>
<td>0.381</td>
<td>0.029</td>
<td>-0.175</td>
<td>-0.351</td>
<td>-0.555</td>
<td>-0.204</td>
</tr>
<tr>
<td>42</td>
<td>Distinguishes f1</td>
<td>0.638*</td>
<td>-0.697*</td>
<td>-0.584*</td>
<td>-1.334***</td>
<td>-1.222***</td>
<td>0.113</td>
</tr>
</tbody>
</table>
The combination of the reported representative factor sort data and the distinguishing and consensus statement data was then used to build a visualization of the representative sort for the factor (Figure 7-1). To create the image, statements were reduced to a three-word combination that represented the sentiment of the phrase (for all combinations, see Appendix D: Three Word Combination for Statements). For example, Statement 33 is “On co-op, I learned how to find and solve problems from my own successes and failures.” This was reduced to “find-solve-success” so that the visualizations could be easily read and evaluated in the qualitative part of the analysis (for the factor and individual sorts, see Appendix E: Visuals of the Factor and Individual Sorts). These visuals were also created for each participant (Figure 7-2). Distinguishing statements for the factor remained identified in the participant-specific sort in the same manner as the representative factor sort. These images were used as critical piece of data during the qualitative analysis.
Figure 7-1: Image of a representative sort for Factor 1 of the 4-Factor solution. Statements with bolded borders were identified as distinguishing statements for this specific factor.

Figure 7-2: Example image of a participant sort, Charlie. This is a digital representation of the location of the statements from Charlie's Q-sort. Statements with bolded borders were identified as distinguishing statements for Factor 1.
7.2 Developing the Profiles

Once participants were factored, distinguishing statements were identified and the Q-sorts were synthesized, participant interviews were open coded to identify salient passages and deepen my understanding of the factor. After all the participant interviews were open-coded, the codes, along with the factor loadings, representative factor sort, and the individual sorts for all members were used to develop a descriptive profile of the factor. This profile was developed using a structured memo technique that included three sections: demographics and descriptions of participants within the factor, similarities and differences between participants within the factor, and a cross-factor comparison. The first section (demographics and descriptions) was developed to provide context for the reader to better understand terminology used or comments made by participants. The second section is where much of the qualitative results are located. Here, central views of the participants within the factor are shared with supporting quotes. The third section is the beginning of the cross-factor discussion that is located later in this chapter. In this section, I would note any noticeable differences in beliefs between participants in one factor over another.

The next section is a summary of each factor including the most central details and key quotes from participant interviews. The factor summary follows a similar pattern as the structured memo with the first part of the summary information to help contextualize the analysis followed by the summary of the viewpoint. First, the participants are introduced through a summary table and a general explanation of each role within the group, then an image of the representative factor sort is provided. A description of the factor with supporting quotes from the interview follows and then a short summary of the
factor. At the completion of this section, a cross factor analysis and synthesis is provided to connect it back to the theoretical perspectives used in developing this study.
### 7.2.1 Factor 1: The Problem Solvers

Table 7-3: Table of demographic information for Factor 1: The Problem Solvers

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Number of Rotations</th>
<th>Major</th>
<th>Gender</th>
<th>Race/ Ethnicity</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charlie</td>
<td>1</td>
<td>Computer Engineering</td>
<td>Male</td>
<td>Caucasian/ White</td>
<td>Developing a code testing suite for computer code developed by other employees.</td>
</tr>
<tr>
<td>Ash</td>
<td>3</td>
<td>Computer Engineering</td>
<td>Male</td>
<td>South Asian</td>
<td>Developing an app for an electronic hardware company to meet customer specifications.</td>
</tr>
<tr>
<td>Adrian</td>
<td>1</td>
<td>Computer Engineering</td>
<td>Male</td>
<td>Caucasian/ White</td>
<td>Developing a user interface to write .xml files that are used in the company products.</td>
</tr>
<tr>
<td>Drew</td>
<td>2</td>
<td>Chemical Engineering</td>
<td>Male</td>
<td>Caucasian/ White</td>
<td>Implementing operator and process improvement projects at a chemical plant.</td>
</tr>
<tr>
<td>Chris</td>
<td>1</td>
<td>Industrial Engineering</td>
<td>Male</td>
<td>Caucasian/ White</td>
<td>Improving manufacturing process through scrap reduction and implementing lean manufacturing practices.</td>
</tr>
<tr>
<td>Gray</td>
<td>2</td>
<td>Civil Engineering</td>
<td>Male</td>
<td>Caucasian/ White</td>
<td>Construction management working with contractors on a build site.</td>
</tr>
<tr>
<td>Toby</td>
<td>1</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>Caucasian/ White</td>
<td>Implementing lean manufacturing processes. Performing process failure mode analysis and six sigma projects.</td>
</tr>
</tbody>
</table>
Summary of Participant Roles

Multiple majors and roles were represented in this factor. The four computer engineering students (Charlie, Aspen, Ash, Adrian) had positions that were more focused on software development than hardware development. Specifically, they were asked to develop programs in C#, an object-oriented programming language like Java or MATLAB. At this institution, computer engineers do not get strong training in object-oriented programming, instead, many of their classes are taught using C which is a procedural programming language and more basic than C#.

Drew, Toby, and Chris all worked for manufacturing companies and were focused on production support and implementing process improvements to increase production efficiency, quality, or both. They all mentioned 5S, six-sigma or other concepts related to lean manufacturing which were central to their role as manufacturing support.

Roan and Gray had unique positions relative to the other participants in this factor. Roan also worked for two different companies on two separate rotations which is atypical of the co-op program. Roan’s first rotation was working at an electrical manufacturing company building electronic test fixtures to evaluate product performance and quality while his second co-op was at an energy company overseeing generator management, inspection, and operation. Gray’s position was in a construction management company where he was contributing to the management of a large-scale construction site. He was responsible for managing sub-contractors, buyouts, and organizing bids for a project.
Figure 7-3: Representative Q-sort for Factor 1. Boxes with a bolded border were identified as a distinguishing statement for this factor.
Factor Description

The reason this factor is called The Problem Solvers is because many of the positively ranked statements in each participant’s Q-sort, as well as much of the interview, centered around finding and solving problems or managing conflicts and unexpected problems. Although their roles influenced what problems would need to be solved, they all discussed constantly having to deal with problems and how to find solutions to those issues.

*On my co-op I was given a lot of independence to try to figure stuff out on my own. I had the help of a mentor that I was working under, but I had to learn how to solve problems on my own, work through them, try to figure it out as much as possible because in school, my teachers always know the answer to the question because they ask the question, but I was solving problems that didn't have a solution yet. So I thought I'd really figure it out on my own to become sort of independent.*

(Aspen)

*I learned how to be thrown into a situation where you don't know the solution but you know that you have tools that you can use to find a solution and you kind of can figure out how to go about looking for that solution. So that's kind of like you never, there's no perfect answer at times, but there's always a way to get started. And that was the biggest thing that I learned.*

(Charlie)

Many of the participants in this group saw the word “conflicts” go beyond interpersonal conflicts or personality clashes. They saw conflicts as something that is not
necessarily bad, but something that needed to be addressed to ensure a successful project. This could be things like use conflicts where two people need to use the same machine or product at the same time, or time conflicts where there was too much work for the allotted amount of time, or need conflicts where the customer may be asking for something that the company is not capable of providing.

*Customers want the app to look [like] this, this and that, but we know programming-wise the challenges we would face implementing this, this and that, so that would be a conflict per se. We would try to let him know "Hey, this is what we can do, this is what we can't", and then we try to work, negotiate and work with him, to give him what he wants but not also drag ourselves into mud.* (Ash)

*Every day in the field, there's always going to be something going wrong and I think the biggest thing I've seen is when you start finishing up a project, the different sub-contractors want to come complain to you about someone else doing something either wrong or not on time. So, [the] painter, he's like, "Hey, you got to get this light guy out of here so I can paint." And so there's just, different- that's where the biggest conflict is just scheduling and just figuring out, say, "Hey can you go work over here while he finishes his paint, and then chase him down the hall that way?" So, that would be the biggest conflict I would say. Just subcontractor management.* (Gray)
Then you have conflicts as in deadline conflicts. You have one group that wants this done, another group has this deadline, and you need to resolve that somehow. Or either of the groups just saying, "You need to hurry up with this," and we're saying, "No, we need more time here, this isn't adequate." So that could be a conflict, one thing I look at as a conflict. And then you may have vendors who come in and who aren't seeing eye to eye with you and you have to resolve that conflict because they'll say, "We need it like this," and we'll say, "No, no, we're doing this." And then you have a disagreement and you have to be able to resolve that. So once I had a responsibility to work with those vendors, I had to resolve any kind of disagreements. (Roan)

Stemming from developing these problem-solving skills, participants in this group felt they also learned how to communicate well from gaining responsibilities and becoming more integrated into the workplace. They talked about building skills to communicate to other engineers more effectively and efficiently.

Learning how to kind of be a little more concise, even though I may not be that right now [in the interview]. That was a new skill that I think I started learning through responsibility and communication with other team leaders and stuff. (Toby)

I think that where it says I learned to communicate effectively with others after gaining responsibilities, well really more so after becoming more integrated into
the workplace. Because the first few times that I had to talk to my boss, it took me a little while to figure out how he liked the information delivered to him and he would always ask me to like rephrase and repeat and I feel like that was an important skill for me because my boss wants me to ask like a lot more cut and dry and concise. Whereas I try to be as specific as possible with my issue. He kind of just needs a general overview. And some of my other coworkers, I think they're a little more patient... Yeah, let me not say [that] because that's not necessarily true. I think they're just more patient willing to like let the air out everything that's in my head and my boss is kind of like, “Okay, we can solve this, but I need you to hurry up.” (Adrian)

When discussing how these skills were learned, the participants would consistently mention that the learning happened when they were given responsibilities and became more integrated into the workplace. Often the word “responsibilities” would be interpreted as “because they trust me to do it” as shown below. Drew is responsible for leading plant walkthroughs for contractors throughout his co-op. At the beginning, he is overseen by his supervisor, but as Drew learns more about chemical and plant safety as well as how to communicate effectively with a variety of employees and vendors, his supervisor trusts him to complete the walkthroughs himself. Because his supervisor trusted Drew on the walkthroughs, he can build skills that can help him in the future.

When you're doing walk throughs with different contractors... I didn't know- The first time I did a walk through, my boss was right there with me as I was doing it
and I did not know what to expect at all. And then once we like started- Then, once he was comfortable with me going about it myself, I had a way better understanding of what they were expecting for me to tell them versus what they were- like what I was expected to know versus what they were expected to know. It was, like, a huge thing because I didn't know that originally. (Drew)

Chris had a similar experience but saw “responsibilities” more as “freedom or independence” than trust. Chris attributes building a variety of skills through this including finding and solving problems, what to expect as an engineer, and hands on skills (machining and assembly skills like using a drill press or selecting which type of saw to use when) that will help him in the future.

Learning to find and solve problems after gaining responsibilities. I mean, pretty much the place I was I had a ton of freedom, so you had a ton of responsibility as a co-op, and that led to, you had to find and solve problems pretty much in everything that you were doing and you were kind of on your own. So I would say I would put that in as super agree because I had to learn how to problem solve pretty much... Since there was so much responsibility on the co-op side, I learned what to expect, what an engineer job is, pretty much... there was a ton of hands on stuff that they had me do and it was super, super new to me. I didn't, like I hadn't used half those tools before, so because I was pretty much industrial engineering, it's like computers and stuff pretty much. So I was doing a lot of hands on, so I would say those hands on skills are probably going to pay off. (Chris)
While there are many similarities between the participant viewpoints in this factor, there are also some differences. Charlie believes there is a distinction between software development and engineering. Although the Aspen, Ash, and Adrian also held roles that focused more on software than hardware development, they did not make this kind of distinction between software developer and engineer.

*I feel like I learned how to be a software developer rather than be an engineer, which there's a difference. It's kind of a fine line, but I feel like I learned more how to be a software developer rather than general engineering ideas of problem solving. I mean those ideas help, but it's more of, like I said, it's more just learning how to program for me... a software developer focuses strictly on high level of abstraction and the programming itself rather than worrying about the physical hardware implications of what I considered to be an engineer.* (Charlie)

Unlike many of the other participants, Charlie believes that because he was more a software developer than a computer engineer, exposure to the field of computer engineering through his co-op is limited. Charlie agrees that his co-op has helped him refine his career goals, but he sees this experience as just one perspective in many.

*I have a better idea of what I want to do is my career now, but I've only had the one experience at the one job. So it's kind of like I don't know what all is out there to be able to make that decision. So for nearly every one of those cards is kind of I had to think about those more than other ones just because of the implications of having the one experience.* (Charlie)
Adrian is one of the only participants in this factor (and across all the factors) who, when asked as a part of the interview protocol, did not want to move a statement over to the +3 column. He felt that the three statements that he had originally placed there were sufficiently representative of his experience and any additional statement was already ‘covered’ by those three.

Right I feel like because like I was saying with this next column is so close to it, like these are the ones that really stand out and then I feel like a lot of these next ones in the columns of five, they kind of fall into these three somehow. (Adrian)

Drew is one of the few participants that mentioned having a personal conflict with other employees and he is the only one that talks about the impact working through that personal conflict was on his experience and learning.

At the site I worked at, there's this maintenance team. There's only, like, two guys and they're bros, but they don't like anyone else really. So, I put that there because my first rotation I really struggled to get any help from them at all. I usually would have to... Like, I'd ask them, they would do nothing. I'd have to ask someone else to ask them for me, then they would do something. Then, my second rotation, I tried more to be less... I would go to them more often than just to ask them for help, and that helped a lot. So, I would say I learned that the first time that I was failing miserably, so that's why I put that one there. (Drew)
Chris had an exceptionally unique experience while on co-op. The company he was co-oping for was going through some serious company issues, the details of which Chris does not know. However, engineers were performing duties that were well below their level of responsibility like running the lines or general maintenance.

Yeah, and like operating a line if the operator didn't show up, they stepped in themselves and did it themselves and that's not at all what I thought I was going to do. (Chris)

There was a significant amount of employee dissatisfaction due to poor management practices. Multiple employees quit in short succession which signaled to the company leadership there may be an issue. Company leadership found a significant number of complaints relating to the engineers, decided that the issues were systemic, and decided to terminate their contracts with several employees. The chaos in the company culminates in many of the employees being fired just before Chris finishes with his co-op.

I mean, for sure, when I was in, to the end, there was like three weeks left and everyone got fired, all the big... like everybody. So, I kind of didn't have a boss for the last three weeks which was super cool, but I would say I learned so much from that that's not on these cards. I learned what the real-world business is from doing a co-op. Not necessarily learning from anybody or learning from my failures, but just learning by being there for that was crazy. You don't really think that happens, but it does. You just walk in and everybody is gone. Well before I thought it was... because my parents work in business like manufacturing and I didn't think they would just walk in and fire everybody in one day. So I learned it's all about making
money and if people working for you aren't happy, then at least in this company the top managers actually listened, because we had a couple people quit within two weeks and that's why the top dogs came in. And then they talked to all the little engineers that were working for them and they just said, threw them under the bus pretty much. But it was cool to see that, that they listened. I don't know if it’s like that in every company, but it is in this one. I wish it had of happened a little sooner...

(Chris)

This has a profound impact on how Chris sees company culture and how businesses work. He sees how employees can be disposable and that has significant impact on his view of business and his role in a workplace. Although Chris sees how dispensable employees can be to a company, he also sees how leadership can listen to employee frustration and appreciated that some employee voices were heard.

Overall, this group aligns most with the theory of metacognition [42], [43]. These participants are developing metacognitive skills related to their roles in their companies. Metacognitive skills are “skills and processes used to guide, monitor, control and regulate cognition and learning” [73, p. 123]. Metacognitive skills can include monitoring, self-regulation, planning, and evaluating [73], all of which are skills that are developed by participants in this factor. For example, Adrian learning how to communicate with his supervisor more effectively. To move his projects along, Adrian must develop and refine the skill of identifying critical pieces of information (evaluating) and determining the best way to explain that knowledge (monitoring). Charlie’s discussion about building his problem-solving approach and understanding that process is an example of metacognitive
planning while Drew monitored his understanding of expectations. Chris’s tumultuous ending to his co-op also influences his understanding of the role engineers have in companies and what is valued by them (metacognitive knowledge) through the process of observing and evaluating the outcomes of a company shake-up. All participants described ways in which their knowledge about knowledge and skills on how to apply their knowledge were built and refined through their co-op experience.
7.2.2 Factor 2: The Apprentices

Demographics

Table 7-4: Table of demographic information for Factor 2: The Apprentices

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Number of Rotations</th>
<th>Major</th>
<th>Gender</th>
<th>Race/Ethnicity</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>1</td>
<td>Mechanical Engineering</td>
<td>Female</td>
<td>Caucasian/White</td>
<td>Designing and building fixtures to reduce assembly time.</td>
</tr>
<tr>
<td>Alex</td>
<td>2</td>
<td>Industrial Engineering</td>
<td>Female</td>
<td>Caucasian/White</td>
<td>Identifying deviations for standard procedures for root cause analysis.</td>
</tr>
<tr>
<td>Campbell</td>
<td>2</td>
<td>Civil Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
<td>Construction management working with contractors on a build site.</td>
</tr>
<tr>
<td>Tyler</td>
<td>3</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
<td>Identifying material defects in parts that could impact mechanical performance.</td>
</tr>
<tr>
<td>Kaden</td>
<td>3</td>
<td>Industrial Engineering</td>
<td>Female</td>
<td>Caucasian/White &amp; Other Asian</td>
<td>Reducing assembly contact time.</td>
</tr>
<tr>
<td>Shawn</td>
<td>2</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
<td>Machine management and troubleshooting to identify and repair poorly performing machines.</td>
</tr>
</tbody>
</table>
Summary of Participant Roles

All the participants, except for Campbell, were working in manufacturing plants either in a quality department (Kaden, Alex, and Tyler) or in process improvement (Winter and Shawn). Typical duties for these participants were to identify, isolate, and resolve manufacturing issues. Kaden’s responsibilities centered around reducing contact time with the part and design of workstations for line operators while Alex’s position focused on root cause analysis and whether operators were following company standard operating procedures for device testing. Tyler’s responsibilities focused more on identifying mechanical defects in parts and isolating underlying manufacturing and assembly issues.

Both Winter and Shawn were more responsible for improving the efficiency of production at their companies. Many of Winter’s responsibilities were focused on design and building fixtures for operators to use to reduce assembly time. She was expected to design, machine, and weld the fixtures for the operators on a team of some engineers and other co-ops. Shawn’s work focused on troubleshooting machine performance for the assembly line. He worked with his mentor to identify machine errors like a clogged tube or broken sprocket.

Campbell’s co-op was in construction management and therefore he spent a significant amount of his time on co-op on construction sites. He worked with contractors and subcontractors to complete their part of the construction project. The company that Campbell works for has a well-respected co-op program and many of the full-time engineers began working for the company as co-ops.
Figure 7-4: Representative Q-sort for Factor 2. Boxes with a bolded border were identified as a distinguishing statement for this factor.
Factor Description

Based on my qualitative evaluation of the representative Q-sort and the identified distinguishing statements, I initially named this group “The Team Players” because many of those distinguishing statements related to team skills. For example, one of the highest ranked statements was “I learned to work as a part of a team after gaining responsibilities and becoming more integrated into the workplace” (Statement 35). The other highly rated statements related to skills that would help a team succeed: finding and solving problems, technical skills, communication skills, skills that would be helpful in the workplace. The second half of the statements (the “hows”) varied mostly between gaining responsibilities, watching, and practice indicating some influence by the full-time engineers. However, upon qualitative exploration of the interviews, the “Team Player” label was not aligning with the sentiments and experiences of the participants. The participants did talk about interacting with their fellow engineers but did not emphasize that they learned through their team. Throughout the interviews, there were few references to formal teams but many references to their coworkers in general. After reflecting on the learning processes described by the participants in this factor, the more descriptive name of “The Apprentices” was applied.

Central to this group’s viewpoint is that learning on co-op occurred through a series of steps: first, they would observe the full-time engineers to better understand the expectations and specific duties, then they would mimic that behavior. As they gained confidence in their abilities, and the confidence of others around them, the students would modify their approach to better suit their own personality.
So I think you learn how to do it the first time by watching the people in your company and doing what they do, and then you really learn it and remember it when you do it a lot by yourself. So I mean, that's the same with new skills, technical skills, communication. I mean all of its kind of a... You watch what they do, and you get the expectations from them of how they want it done and what they want done, and then from there you kind of just mimic them. And you put your own little twist on everything, but for the most part you gain responsibility, you're given a new skill, they teach you how to do it, you repeat it, and that's how it goes. (Campbell)

Two of the three cards, I learned whatever the category was by observing. I would say that's just generally how I learn best is by observing others and what they're doing, trying to mimic that or learn from their mistakes. I'd say a lot of the cards progressed that way. At the beginning of my co-op experience, I was more relying on observation and things like that, and towards the end, it was more about my successes and failures. That made it kind of hard to pick one or the other... if I had to rank the categories overall, I would say observation was number one. Gaining responsibility was probably number two. Repeated situations was maybe two or three. It could be flip-flopped. Then successes and failures, and then reflection if I had to rank them like that. (Tyler)

Just the whole communicating thing, that's like a learning curve. My first rotation, I was not good at it at all. But after doing it some and watching others do it, seeing
the effectiveness it can have if you do it well, definitely motivated me to try and get better at it. (Alex)

[I agreed with the] ones that have "watching other engineers." Especially my mentor, I know a lot of what I do now. Even when I just sit down and do something, I think about the way that he does things. (Shawn)

Specific skills these participants developed in this way were “to find and solve problems” and “manage conflicts or unexpected problems”. When talking about finding and solving problems, they talked about seeing an approach that they had never seen before.

It's like my first week or so I was just literally following my engineer around and we'd just watch what they were doing and do a time study and then evaluate, okay these are the places in which we could decrease our time, or this is where we're losing our cycle time and this is how we can improve that. So that was something that I'd never even thought about before; like how to look for the problems and then how to come up with the ideas to solve them. (Winter)

This was a big one for me, learning to find and solve problems by watching the engineers and what they're doing. I was in a quality department, where we were trying to find defects in parts and materials that were coming in, and testing these out. At the beginning of my co-op, I didn't really have an understanding of what we
were looking for as far as defects and things like that, but by watching my mentor and the other engineers I was working with, I gained a lot of insight into quality and those sorts of things. That was a pretty big deal for me. (Tyler)

Students talked about developing their conflict management skills by watching the discussions and negotiations between multiple engineers or engineers and operators.

"On co-op, I learned how to manage conflicts or unexpected problems by watching the engineers in my company in what they do." I would say this, just because I sat through a lot of meetings where there are many departments in there. There are definitely a lot of disagreements and different perspectives on how to solve a problem and all that. So, definitely just seeing how they talk through those situations and handle that and come to some sort of resolution, even if it takes several meetings. That was definitely an experience I hadn't had before co-op that I think helped a lot... I can just think about a few meetings where they handle things in ways I never would have thought to, but really ended up accomplishing what they were trying to. (Alex)

In my co-op, we had a daily wrap-up presentation every day. I was not the one presenting, but I created these presentations. There would usually be disagreements or conflicts at each of those meetings. I wouldn't necessarily be actively participating in these discussions, but I would be observing everything they were saying, and just seeing how they were talking to each other and things like
that was influential in me for conflict mediation and stuff like that. And just how to deal with people who are sort of difficult in a nice way. (Tyler)

Because a lot, going back to what I learned from the engineers, a lot of the problems we were having was with other people and operator discipline and operator errors, and not things that were actually wrong with our machines which makes it more difficult to know how to solve them. And so, I didn't even know how to go about that in a way. And the engineers they've had more experience with it and they know how to talk to the operators without belittling them. (Winter)

[I]n my experience, the engineers didn't have necessarily, they weren't really above, I don't know if that's the right word, but they didn't really have any authority over any of the people that we would work with. So we would have to figure out ways to get people on board with the projects we wanted to do. Because we couldn't necessarily say, "All right, these are the projects, go do this part." But we would have to convince them that this is a worthwhile project. So just realizing that I don't fully know how to do that and watching other engineers and seeing how they would go about doing that and who they would communicate with helped me learn what my role would be in the company. (Kaden)

Students also talked about how gaining responsibilities and trust of their fellow engineers positively impacted their learning.
When I first got there, I would watch other engineers and kind of be like, "All right, I don't know what they're doing or how they're like getting their roles." I was a little bit lost when I first got there. But then the more that I had regular responsibilities coming up and a little bit more trust given to me I felt like I was actually part of the workplace and I actually felt like I was part of the engineering team per se. And people would know me by name as one of the engineers. (Kaden)

"On co-op I learned new skills that will help me be successful in the workplace after gaining responsibilities and becoming more integrated." I do feel like they gave me a decent amount of responsibility, especially my second rotation. I was forced to learn a lot of new skills, like I had to teach myself VBA and Access and all of that, so I feel like that will all help in the future. Just having to learn something on your own, when it's needed, I think was helpful too. (Alex)

Once you've gained responsibility within the company and within your project team, they can trust you to solve a problem. It's not hard to find a problem, problems are everywhere. But they won't trust you to solve the problem until you gain that responsibility and you're integrated into your project team. (Campbell)

A central skill that these participants developed was communication skills and being able to communicate effectively with others. These skills were honed mostly as they
watched others communicate or after gaining responsibilities and having to communicate on their own.

[I]t's all well and good to take a class and communicate like this and email etiquette and talk on the phone. But until you start doing it, you never know what the person on the other end of the line is going to say, so you just got to kind of learn it. Once you have that experience then you can build off that, for some reason your communicating isn't going as well as you thought it would. (Campbell)

[T]he big thing I noticed on co-op was my communication skills did get better and I got a lot more comfortable communicating. And especially this one was about being more integrated into the workplace. I felt more comfortable going to upper management or not upper management, I guess middle management and different people that I had previously been a little bit intimidated by. And then the more, the more responsibility I had, the more I felt like I had an actual reason to talk to these people without having that fear of any wasting their time or things like that. (Kaden)

But I learned how important communicating with others is. Because there are sometimes, I would work with some of the other co-ops, and I would be, I would expect them to know the baseline of the problems. So I would just say, okay, we need to go work on the weld fixture and I need you to assemble the base plate and so you'll need to go and get the bolts and stuff. And I would just assume that they knew how to do that and then I'd come back, and it would be done wrong. And I
would realize that it wasn't their fault. It was my fault because I didn't communicate effectively with them. I didn't tell them exactly how to thread the holes and then what bolts to use for the holes and so then I ended up having to drill the holes out larger for everything, re-thread them, because they had threaded it crooked, and then rebuild them in myself. So it would have just saved a lot of time if I had been able to communicate more precisely. So that's something I definitely agree with, is how to communicate exactly what needs to be done and how to do it kind of.

(Winter)

Participants in this group were likely to work extensively with others whether that be other engineers and co-ops in their department/team, operators on the manufacturing floor, or subcontractors. These interactions fostered opportunities for the participants to hone their skills and hear a variety of perspectives which helped them when they approached new problems.

[A] big part of my experience was getting to sort of talk with the operators and then take my conversations with them and then turn that into a system or process that can benefit and help them. So maybe just getting interaction with people outside of the engineering field and getting to talk with them. (Alex)

And that was where I figured out, okay so, we want, we need to build this, but we only have this much space to fit it in. So that was before you started building you needed to identify what problems you were, based on time constraints like; how
much time you had to build it, all your material constraints, your size constraints, and that was stuff that I learned after they gave me the responsibility. [The engineers would] be like “Okay, you need to plan this out, you need to go design this based on all the constraints, identify your constraints, and then come back to a plan.” (Winter)

Those social interactions at work extended into spaces away from work as well. Participants saw how the social relationships they developed outside of the professional realm had impact and influence on their sense of belonging and their career decisions moving forward.

Me and my mentor would get meals together occasionally, talk about life outside of work, not strictly work things. Yeah. I would also attend car shows and I would see coworkers there, so it made it more, I don't know, cohesive. My team had a Christmas party outside of work, unrelated to work. So it made our personal relationships stronger at work by hanging out outside. That was one of my favorite aspects of my co-op was just the people that I was working with. I gained a lot from them, and it was a fun experience, so it was good. (Tyler)

There is a personal relationship [with my mentor] as well. We've had, if you want to call it off the record, conversations just about career choices in general. Just as someone who's graduated and has been working as an engineer for several years... It definitely helped me to make thoughts about my career path in the future. (Shawn)
Many of the participants had positions in quality departments and regardless of their major, they felt that there was little overlap between their engineering coursework and their job responsibilities.

*I feel like I didn't really do that much related to my major, in my co-op. So, I'm industrial engineering. And there were some aspects of industrial, but very little compared to everything else.* (Alex)

*For me, my connection was pretty minimal to be honest. That was something that I wasn't necessarily mad at my co-op for. I was more angry with [Institution] because I feel like we didn't get enough training on manufacturing or dimensioning and tolerancing, which was the fundamental basis of my co-op because those are more like real-world applications for things. Even my manufacturing class that I took that Spring after my first co-op didn't really go into what I was dealing with on a day-to-day basis. It was more on the technical aspects that were already predetermined, at least in my company, before it got to us.* (Tyler)

But the students appreciated the structure of the co-op system and the limited responsibilities that it afforded them. They found that it was an opportunity to try different engineering roles but also be protected from “the big things” that the full-time engineers were responsible for.
It's a nice way to dip your toe in because you have some responsibilities but you are just a co-op student, and so they don't have this huge weight and expectations and you're not costing the company a ton of money. Whereas when you're an engineer, it's more definite your fault and your responsibilities. And so co-op gives you a nice introduction into life and how that works and helps you to figure out if that environment is right or would work for you. (Winter)

I think that the co-op gives you a very good insight into how the real-world works, but in a way that you're not just thrown into the deep end... I think the things I've learned and just the expectations of the real-world and how I was told to do things was in a way that the company doesn't expect you to know everything, and they know that you're not going to be super knowledgeable on a specific type of building. But they know that if you're in engineering, you know how to think, and if you're given the opportunity to build your knowledge then a lot of people can do that. And having multiple rotations allows you to build that. It's not just one internship whereby the end of it you're just starting to gain responsibility and it's all for nothing. My first rotation, I didn't really have much responsibility but by the end of my second one, I was kind of managing myself and reporting back when they wanted an update, not having them hold my hand, look over my back every second. And I'm hoping that this next rotation will be even more a step above that. (Campbell)
And expecting as an engineer? No, because sometimes co-op is different than being an engineer. I think you gain that from more working on teams... A lot of times [the co-ops] don't deal with the paperwork and stuff like that side, and big documentation. We do some but, as far as the meat of documentation, we're not usually, or I'm not at least. I'm not involved with that. Some, but not near as much as a full-time engineer probably would be... Maybe you don't feel as much responsibility? You try to but, at the end of the day when it's all said and done, probably not. (Shawn)

Although all the participants positively ranked many of the cards relating to "gaining responsibilities and becoming more integrated into the workplace", Campbell ranked almost all of those statements positively. His role in construction management instead of quality or failure analysis may have influenced a stronger positive opinion of gaining responsibilities and becoming a part of the team. Additionally, Campbell positively ranks developing skills relating to working as a part of a team which matters more to him than the other participants.

The co-op I do is not in a big office. It's on job sites. And so becoming part of the team is about the most important thing you can do. And that's just a factor of becoming integrated into the team when you first get there. And as you gain more responsibility, you become more of a part of the team. (Campbell)
Alex’s experience was the opposite; although she learned through gaining responsibilities, she spent most of her time working independently.

*While I was in some meetings with engineers, my job was very independent, and it was a majority of work on my own. So, I didn't have a ton of interaction with the engineers on a regular basis.* (Alex)

Tyler was on the other side of the spectrum for this group, moderately ranking statements related to gaining responsibilities but ranking all the statements ending in “by watching the engineers and doing what they do” positively.

*Two of the three cards, I learned whatever the category was by observing. I would say that's just generally how I learn best is by observing others and what they're doing, trying to mimic that or learn from their mistakes. I'd say a lot of the cards progressed that way.* (Tyler)

While many of the participants expressed that they learned conflict management and negotiation from watching the engineers, Kaden felt like she did not. She believes that she was not able to observe the conclusion of any of the conflicts she witnessed and so that limited what she could glean from it.

*There's a few in here on the disagree side where I put "learning how to manage conflicts or unexpected problems" because I didn't really feel like I got a lot more understanding of how to manage conflicts while I was there. Just because I didn't run into a lot of conflicts. Or when there were conflicts, they were between other*
engineers. I didn't necessarily see how they were resolved. So I didn't really get much from that. (Kaden)

While Kaden did not find that she learned much conflict management, Shawn did not feel he learned how to communicate with others. He felt like those skills were already well-developed in him and he did not need his co-op experience to build them.

[I disagreed with] "learning to communicate by watching others." because I think I communicate fairly well, but I don't know that others there do. So I don't learn by watching what they do then no, but maybe that works for them. (Shawn)

The Apprentice factor most aligns with Lave and Wenger’s Situated Learning [39]. In this learning theory, individuals learn through social interactions with established members of a group through the process of legitimate peripheral participation. Learners become incorporated into the community through practicing authentic tasks and gaining more responsibilities as they are recognized by established members [39]. In this factor, participants discussed the way they learned was through the process of observation, replication, and internalization. In their first step, participants would observe established members to learn the basic skills and standard practices in that community. Then, over time, they would be assigned authentic tasks that required additional skill and understanding. As they integrated into the community, these participants began to identify with that community themselves as expressed by Kaden feeling like she was being recognized as a part of the engineering team.
7.2.3 Factor 3: The Doers

Demographics

Table 7-5: Table of demographic information for Factor 3: The Doers

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Number of Rotations</th>
<th>Major</th>
<th>Gender</th>
<th>Race/Ethnicity</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jules</td>
<td>4+</td>
<td>Industrial Engineering</td>
<td>Male</td>
<td>Caucasian/White</td>
<td>Helping move manufacturing lines to another facility.</td>
</tr>
<tr>
<td>Corey</td>
<td>3</td>
<td>Industrial Engineering</td>
<td>Female</td>
<td>Caucasian/White</td>
<td>Process improvement and overseeing lean events monthly.</td>
</tr>
<tr>
<td>Bobbie</td>
<td>2</td>
<td>Industrial Engineering</td>
<td>Female</td>
<td>Caucasian/White</td>
<td>Software support specialist. Software is used heavily by IEs.</td>
</tr>
</tbody>
</table>
Summary of Participant Roles

This group was the most similar with all three participants majoring in industrial engineering. Jules and Corey worked at manufacturing companies but with different day-to-day responsibilities. Jules was helping his company transition a manufacturing line from his location to a plant located in Mexico. Jules became the expert in the plant layout and would spend a significant amount of his time deciding where machines or lines would be placed. Corey, on the other hand, was more focused on process improvement with her participating in a lean event every month in a different part of the plant. While Jules and Corey were located in a manufacturing company, Bobbie worked as a support specialist for a company that developed a software program that is often used in manufacturing and is heavily used by industrial engineers. Many of her daily responsibilities centered around working on support tickets and fixing code, working both in their proprietary software and SQL.
Figure 7-5: Representative Q-sort for Factor 3. Boxes with a bolded border were identified as a distinguishing statement for this factor.
**Factor Description**

Participants in this factor described learning a variety of skills through the act of doing. As seen in the factor sort data above, they learned “skills that will help them be successful in the workplace”, “how to manage conflicts”, “how they learn and how to learn”, “how to communicate effectively with others”, “what to expect as an engineer”, and “what I want from my career” mostly through “gaining responsibilities and becoming more integrated into the workplace” and “repeated practice”. These students disagreed that they learned from reflection or from watching others.

*I also feel like I was able to develop, obviously, my technical skills a lot and much of that was through just working, just getting assigned problems and working through them (Bobbie).*

*And I guess the only way to learn that is to do it, there's only so much you can talk about before you have to just do it to kind of understand how it all works (Jules).*

*Watching engineers in my company was something I disagreed with a lot and I think it's partially because of the way I learn, but also partially because of the nature of my work environment. I don't learn really by watching others, I learn by stumbling through on my own, following instructions. I don't typically watch others to learn (Bobbie).*

All three participants believed that part of the reason they did not learn through watching was because there was not an industrial engineer who they worked with closely.
to observe or that person was not often available. Although they worked with people on projects, they did not work on a cohesive team.

*I'm an industrial engineer there weren't many engineers there. There was only one industrial engineer and I never really worked with him. And most of the other engineers had mechanical or chemical engineering backgrounds. So I didn't really learn a lot about my specific discipline from them. And if I did, it was pretty general. Like, any engineer could step into their position and do what they could (Corey).

*[T]he environment was very ... you're at your desk, you're doing your work, so you're not really going to go over to other people and watch what they are doing. Because also, they're probably solving a problem that is not related to what you are doing. There is a lot of one-off problems people have and ... I mean I would reach out to people if I was stumped, but in that case, it would be them solving it with me, it wouldn't be me learning directly from them (Bobbie).

*Especially as an industrial engineer, there wasn't really any IE going on it was a lot of managing a bit of a disaster in a way because they were doing a lot of different things with moving their facility to different locations and stuff... So, there was I think even in maybe the first week of my co-op my mentor wasn't even there, so I really didn’t do much my first week. It got going after that because I started getting more stuff, but there was instances like that where I wouldn't even have engineers, IEs, to watch do industrial engineering work. (Jules)
There is strong agreement on working with and communicating with others. All found they had built communication skills through their co-op.

I’d say that and just working with people. Because I think no matter the job you have a lot of it is just how do you work with your coworkers, how do you work as a unit, as a team. If there’s problems with coworkers, I experienced that a few times, not with myself but seeing other people maybe having a little bit of a conflict. How much it can be detrimental to the team aspect. So just in a way, learning how to work in a unit together with other people (Jules).

Definitely learned how to communicate with people, both within a team and then outside of a team. And by that I mean reflecting what we’re working on to an outsider and making it concise… And just because you have an engineering degree doesn’t mean you know everything. I learned a lot about communication (Corey).

I definitely learned a lot of skills about communicating with different types of clients, like someone that's on a manufacturing floor is going to talk a lot differently than someone who is a plant manager. So learning to talk to people on different levels, and then also working within the company, expressing the needs of those customers clearly to everyone within the company, or whoever you are working with (Bobbie).

Both Bobbie and Jules talk about the difference between communicating in college or at another kind of job (like a restaurant) and an engineering workplace. Corey talks about
building communicating skills and learning how to be on someone’s “team”, but she does not directly compare communicating skills in her co-op to other places like school or other jobs.

“Workplace communication is a lot different than college communication... I feel like when you are in school it is definitely a little more laid back. People don't have as high of a professional expectations of you in college, but then when you get out into the workplace, you have to be professional all the time, and then also, you're just going to be talking to a lot of different ages, a lot of different types of people in the workplace, whereas in college, you're generally just talking to students and just professors (Bobbie).

I guess I'd just never been in a professional environment, so I'd never had a chance to kind of communicate with other engineers, I'd always just kind of work in a restaurant or something back home, back in high school and my first summer of college. So, I guess a big way of just communicating effectively both with some of the customers I would talk with, just emails, phone calls, team member, team to team. Even myself, as a co-op, to maybe a line worker as well, just kind of how to talk with each party, piece it all together (Jules).

Additionally, there is strong alignment on the disagree side of the sort. The biggest statement that they disagreed with intensely was “how much I don’t know”. While Corey and Bobbie felt that they came into their co-ops with an open mind and an understanding
that they would not know a lot in the beginning, Jules felt he wasn’t challenged in his co-op and therefore didn’t ever feel like he didn’t know what was going on.

*I didn't really like the ones that how much I don't know, because I never really thought about how much I didn't know. It was just more of like, continually learning new things. And I was never really sure of what I didn't know... I had a positive experience with my co-op and I kind of was thinking of it as like, how much I did learn and not necessarily what I didn't get out of it* (Corey).

*I don't know why that [statement] doesn't resonate with me. I guess I acknowledge the fact that I didn't know a lot of things going in, but I don't feel like I learned how much I didn't know because I already knew that I didn't know these things. I didn't go in thinking that I knew everything and then all the sudden, was hit and realized I didn't know them initially* (Bobbie).

*I think it was a good co-op, but in a way I felt like I wasn't fully utilized in parts of it and a lot of that might have to do with what I don't know. I feel like I didn't really get thrown into a lot of stuff that was complicated maybe where I would feel overwhelmed or feel like I can't do it. A lot of the projects I got I felt like I could do and maybe that's a good thing, I don't know. But I feel like in the same idea they weren't necessarily difficult problems it was more, I mean not busy work I wouldn't say, but it was more simple IE stuff* (Jules).
All three talk about how their co-op experience had influenced them when making
career decisions. Bobbie and Corey were not fully satisfied with their role, they felt happy
enough while on co-op, but did not feel they could continue in that role for their career.
Corey does not want to work in manufacturing, she is more interested in sourcing or
healthcare while Bobbie wants to pursue an advanced degree. Jules also used his co-op to
help him decide about his future. He was not as dissatisfied with his co-op as Bobbie and
Corey were, but he was not fully excited about it either.

[This summer I'm doing a sourcing internship and that is kind of tied up in
manufacturing. One of the projects I had during my co-op was dealing with
sourcing but on the manufacturing side. So I'm going to try it, doing the sourcing
role on the other side coming from the vendors and whatnot. But I could also see
myself doing like, consulting or working in health care. And both of those, kind of
because what I did enjoy from manufacturing was helping people, like one on one.
Seeing the direct effects of that. And I think I'd get that more out of consulting or
working in health care (Corey).

I came out of my co-op position realizing that I wanted to stay in school and get my
PhD. So I just learned more about what a workplace environment is like in general
and I didn't love it. I preferred school and I ... it reaffirmed this thought that I
wanted to go to grad school and pursue being a professor (Bobbie).
I guess I just always thought the job I had would've been a seven out of ten job and so how much chance do you want to take that another job you take somewhere else is one of the other less than seven out of ten, but what chance do you want to take that you'll have a better job, a better idea of the job beforehand? ... I'm a little lukewarm on it, but like I said a little more warm than cold for it. (Jules)

Although there is strong agreement with each participant’s sort, Bobbie does have some divergent views. Bobbie is the only person in the group that positively ranks statements related to developing technical skills. She ranked three technical statements very high relative to the other two doers: “technical skills from responsibilities”, “technical skills from repeated practice”, and “technical skills from my own successes and failures”. She ranks these very high because a majority of her job is to work through software issues and develop new code which she considers a technical skill. This is very different than Jules and Corey who did not believe they developed technical skills.

So, I learned a lot of technical skills in my position. We work with the software and so I learned a lot of SQL and a lot of coding languages and also just how to work with the software, and how to configure, and I feel like I learned a lot of technical and software-based skills (Bobbie).

And then also a lot of the soft skills I learned in my co-op. Not really a lot of technical things like, do this to make it more efficient or do this to reduce time. It’s a lot about working with people, because a lot of the stuff we did was team based (Corey).
I just wouldn't say I had successes or failures with a lot of technical skills just because I didn't really have any deep technical skills. (Jules)

The disagreement here is not concerning because Bobbie’s job context is very different than Corey and Jules. While Corey and Jules were working with people in product management, Bobbie was troubleshooting code, something she defines as a technical skill. Additionally, Bobbie says that she developed her coding skills through doing (i.e. responsibilities, repeated practice, successes & failures). She learned something different than the others in her group, but she still learned it through the same way.

Corey ranks statements related to managing conflicts much higher than the other two participants. This could be related to Corey’s role and what was expected of her. From her lean events, Corey would be expected to work with line operators to improve efficiency and those operators might not be happy with those changes. She may have had to deal with more interpersonal conflicts, but she does not expand on these statements in the interview. Like Bobbie, although the skill learned was different, Corey does learn it through doing, especially through practice and her own successes and failures.

The Doer group best aligns with Experiential Learning Theory (ELT). ELT consists of a four-step cycle that constantly repeats for the learner. The first step of ELT is that the learner has a concrete experience which immerses the learner and requires them to react intuitively, like Bobbie describes her learning process. She felt she needed to be the one to complete the tasks or she might not learn the skill. After their concrete experience, the learner should reflect and observe by considering alternatives similar to how Corey learns.
more about effective communication. Corey saw how she would need to communicate to a variety of coworkers in different contexts. By reflecting and observing how her coworkers were responding to her, she could develop effective communication skills. After reflection, comes abstract conceptualization. Jules shows this by his discussion of standard communication practices in different contexts like school, as a server, and as a co-op. He abstracts his reflective observation to a theory that his different roles will require different communication skills and knowledge. The last step of the cycle in ELT is active experimentation where the learner is testing previously generated concepts and refining their knowledge. How Bobbie talks about building her coding skills is strong evidence of that. Every new ticket she is assigned, she refines her understanding of the software and the SQL language.
### 7.2.4 Factor 4: The Deciders

#### Demographics

Table 7-6: Table of demographic information for Factor 4: The Deciders

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Number of Rotations</th>
<th>Major</th>
<th>Gender</th>
<th>Race/Ethnicity</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devin</td>
<td>2</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>White/Caucasian</td>
<td>Supported full-time engineers at a construction management company.</td>
</tr>
<tr>
<td>West</td>
<td>2</td>
<td>Civil Engineering</td>
<td>Male</td>
<td>White/Caucasian</td>
<td>Modeled new transmission lines for a large energy company.</td>
</tr>
<tr>
<td>Dale</td>
<td>3</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>White/Caucasian</td>
<td>Manufacturing support at a small manufacturing company.</td>
</tr>
<tr>
<td>Julian</td>
<td>1</td>
<td>Mechanical Engineering</td>
<td>Male</td>
<td>White/Caucasian</td>
<td>Designing products for clients using CAD.</td>
</tr>
</tbody>
</table>
Summary of Participant Roles

Each participant in this factor had a relatively unique set of responsibilities relative to the other participants in the factor. Devin worked at a construction management company where he described his duties as “to do busy work.” Devin did not enjoy his co-op experience and is the participant with the most negative opinion of the experience. The other mechanical engineering majors in this factor worked in a manufacturing facility. While Dale worked at a small manufacturing company and had projects related to “fixture design, scrap reduction, [con]tact time reduction, and generally keeping production running smoothly”, Julian’s work was more focused on design. Julian was asked to build CAD skills and then work with another co-op to design products based on client specifications. Lastly, West worked as a civil engineer at a large energy company. He mainly worked in CAD and other modeling programs to ensure new transmission lines were placed in the right locations, taking into account features of the land, environmental impact, political impact, customer demand, etc.
Figure 7-6: Representative Q-sort for Factor 4. Boxes with a bolded border were identified as a distinguishing statement for this factor.
Factor Description

The most central view of this group, and why they were named “The Deciders” is the highly positive rating of the statement “I learned more about what I really want to do with my career when I reflected on my co-op experiences and thought about my learning.” This was the highest rank reflection statement across all factors and this group ranked this statement significantly higher than the other groups.

*The big takeaway I got is just what I want out, not just a career but out of life in general. I learned that by working on the co-op and just seeing what the working life is like outside of working.* (Devin)

*When I went into co-op, I really wanted to do design... But I was only working for about two months before I realized that, manufacturing is really more what I was passionate about because I really liked working with people. I like seeing people succeed. And I liked helping the bottom line. I like seeing a dollar amount attached to the work I was doing. So, that completely changed my perspective about what I wanted to do.* (Dale)

*[T]he [co-op] positions that I've been in were a little bit of design work, and I've also realized that that's not exactly what I'd like to do... *[T]his is my first semester that I haven't been on rotation in a minute. So I've had a lot of time to reflect and think about it to figure out what I want to do.* (West)
I spent a lot of time thinking about what I was doing... [My co-op] solidified my choice to lean away from engineering and go more towards physics, and really thinking about what I was doing, and did I like what I was doing? How was I benefiting, how's the company benefiting? Do I want to keep doing this for the rest of my life? That was something that impressed itself on me. And I really strongly agreed that I figured out a lot of what I wanted to do as a result of that. (Julian)

All four found the co-op to be heavily influential on career decisions. Devin decided to enlist in the military after graduating with an engineering degree, Julian decided to expand his minor in Physics so that he could work in system modelling and computation, Dale decided to work in manufacturing support at a manufacturing company, and West was still undecided on exactly what he was going to do, but felt his co-op was helping inform his continued exploration.

They all felt like the co-op experience helped them have a better understanding of what it meant to be an engineer and what to expect they would be doing in a full-time job. They used the co-op experience to expand their understanding of what their fields looked like in the real-world and used that information to make decisions related to their careers.

I kind of went in to this co-op with an idea and my plan going into the going into the co-op was actually, “I'm going to go see what the real working world is like and if I don't enjoy it I'm gonna join the military”, and the more integrated I got into the office I went “yeah this isn't for me...” before I was kind of on the fence
and I didn't really know what I wanted to do but now I have a goal in mind that I want to pursue. (Devin)

When I went into co-op I really wanted to do design, the cutting edge design is what they really push in a lot of my undergrad classes. But I was only working for about two months before I realized that, manufacturing is really more what I was passionate about because I really liked working with people. I like seeing people succeed. And I liked helping the bottom line. I like seeing a dollar amount attached to the work I was doing. So, that completely changed my perspective about what I wanted to do. (Dale)

Devin, Dale, and Julian all discovered what they do not want to do while on co-op. While West’s and Dale’s experiences are far less negative than Devin’s, they still found something they were not interested in continuing: Design. The difference between West and Dale and Devin is that both West and Dale did not feel as defeated about the co-op experience as Devin. West seemed to be comfortable with the down time that he had in the office, using his time productively by watching the engineers working on other projects or asking them questions about what they were doing. It is unclear of whether Devin behaved in a similar manner as he did not mention it during the interview.

Each participant expressed that they observed a significant amount of down time which gave them time to think, observe, or reflect on their experience.
I just really hated getting up at six everyday then going to work and just sitting there, waiting for what little work there was to do that day to come to me. Then just turn thirty minutes of work into eight hours of work. (Devin)

These students did not just evaluate whether or not they were interested in their respective fields because of their direct role and responsibilities, they also watched other engineers and reflected on the whether they would be happy performing those duties instead.

Another one is what do I want to do? Even if what I was doing wasn't exactly what I wanted to do, I saw people that were doing other stuff, and I gathered ... I got to ... so we went on a different site visits, so I get to, maybe not work with, but shadow a lot of other different people with different jobs. So that's the more ... that's what I learned was not nitty gritty stuff, but big stuff, which I'm not sure ... I don't remember what I was expecting out of it, but that's definitely what I got out of it. (West)

I saw even people who were co-ops and had been there a couple of years were still doing things I probably didn't want to do. (Devin)

Out of the entire group, Devin is the most negative about his co-op experience. He does not describe his co-op experience in a positive light and does not feel that he gained any skills from his co-op while the other three participants felt there was more value to
their experience. Ranking the participants in order of positive experience to most negative, it would be Dale, West, Julian, Devin. However, Devin would still encourage other students to participate in co-op. He is extremely grateful for his co-op experience specifically because he did not enjoy it and can confidently focus his efforts on completing his degree and then transitioning to the military.

Interviewer: Would you recommend co-op to other students?

Devin: Yeah, absolutely. There were other co-ops students and they seem to adjust to it pretty well. In general, I've heard of other people having good times co-oping. Like I said, before I was kind of on the fence and I didn't really what I want to do but now I have a goal in mind that I want to pursue.

West does not significantly differentiate between the two phrases “repeated practice” and “integration into the workplace” because the way he was integrated into the workplace was through a repetitive practice of updating or reviewing CAD drawings.

I kind of thought of the “repeated practices” and “integration into the workplace” kind of as the same thing. So a lot of the work I was given was not busy work but small things that I could do that didn't require a lot of technical understanding, so a lot of AutoCAD drawings or just simple reviewing drawings. So that was good for me because I got to understand just a lot of the physical components that we were working with, but the repetitive work and the integrated into the workplace was kind of two birds with that one stone of just kind of, "Hey, can you do this real quick, or I've got the couple things I left on your desk. Can you do that?" (West)
West also ranks the statement “On co-op, I learned new skills that will help me be successful in the workplace by watching the engineers and doing what they do” distinctly higher than the others in the factor. West is the participant that talks most about learning new skills and new technologies while on co-op, including how to build suitability maps using ArcMap and how to approach material on the professional engineering exam. The other participants do not believe they learned many new skills, if any, and if they did learn them, it was not through watching other engineers.

West ranks the statement “On co-op, I learned more about how I learn and how to learn from a variety of experiences by watching the engineers in my company and doing what they do,” dramatically lower than the other participants. When asked what card he could move over to the strongest disagree column, he picks this one.

West:  I can pick one easily, I think. I think I’d move this one over actually.

Interviewer:  “About how I learn by watching the engineers.”

West:  I think that’s just kind of a, I’m not going to learn anything about me by watching other people. That makes sense to me.

Interviewer:  It all it needs to make sense.

West:  I’ll learn just about anything else from other people, but I’m not going to learn anything about me from watching them.

Another important part of Dale’s experience is getting a better understanding about how much he did not know about the corporate world and of engineering in general. He was confident going into his co-op thinking he “was going to change the world and it was
about 15 minutes before [he] realized that wasn't going to be the case.” He quickly realized that the faster pace of a classroom (with week-long turnaround times) was not representative of the real world. He also noticed the limitations of his classes. Details like how feasible a design is to manufacture were not a part of his course experience but were necessary skills for him to be successful as an engineer.

*It was my first day when they gave me a design, or they gave me a design project and I built this fixture. And then, that was the first iteration and it took eight iterations for me to get it right. I was like, wow, I thought it was hot stuff, but I really had no clue what I was doing. I don't understand tolerances, I don't understand how stuff's manufactured. I don't understand that you can't make a hollow cube. You can't machine a hollow cube with only a single piece of metal. Stuff like that. It wasn't necessarily covered in my classes.* (Dale)

The Decider group aligns mostly with Social Cognitive Career Theory. As each of these participants continued through their co-op, they gained a better understanding of their career interests. Additionally, they refine their outcome expectations and gain a better understanding of what the day-to-day responsibilities would be if they took a full-time job that was similar to their co-op position.

7.3 Cross Factor Analysis

To compare across factors, I returned to the representative Q-sorts and identified which statements were located in what part of the Q-sort by counting the number of cards with either a specific “what” or “how” (Table 7-7, Table 7-8). This was done to identify if
there were specific parts of the statements that were more common in one factor over another. The Q-sort was divided into three sections consisting of positive (+3, +2, +1 scores), neutral (0), and negative (-1, -2, -3). Then each statement that related to that subphrase was counted and tallied. Qualitative and quantitative data indicated that the Problem Solver factor and the Decider factor focused more on what skills and knowledge was acquired on co-op rather than how that learning occurred. Conversely, participants in the Apprentice factor and the Doer factor focused more on describing how their knowledge and skills were acquired.

The Problem Solvers ranked four main skills positively: how to manage conflicts or unexpected problems, new skills that will help them be successful in the workplace, the technical skills of their discipline, and to find and solve problems (Table 7-7). They primarily gained these skills from gaining responsibilities and becoming more integrated into the workplace (Table 7-8). Of all the factors, the Problem Solvers had the broadest definition of conflicts, expanding beyond interpersonal conflicts and incorporating other types of conflicts like timing or need-based conflicts.

The Deciders, instead, learned more about what they really want to do, what to expect as an engineer, and how much they did not know (Table 7-7), learning through a variety of avenues including watching the engineers, by repeated practice, and after gaining responsibilities (Table 7-8). Although many participants in the other factors did use their co-op experience to make career decisions or refine career goals, their career decisions were not the most salient part of their experience. For the Deciders, it was the most important part of their co-op. This group included the participants with the highest
dissatisfaction with their co-op experience; however, they were also the most passionate about and supportive of other students participating in the co-op program.

The Apprentice factor and the Doer factor are relatively similar to each other. The Apprentices rated more of the “new skills” statements positively and the Doers rated more statements related to managing conflicts and learning more about what they want to do with their career positively. Additionally, both factors positively rated statements related to learning through gaining responsibilities at a similar frequency. The critical difference between these two factors are the other positively rated “how” statements. In the Apprentice group, the other most common “how” statement relates to watching the engineers and emulating them whereas in the Doer group, the other most common “how” statement relates to repeated practice. These quantitative differences are supported by the explanations the participants provide which are documented in the profile summaries above.
Table 7-7: Frequency counts for each "what" statement and its location in the representative factor Q-sort. Numbers in parentheses represented the total number of statements associated with each column or row. For example, there were three statements relating to learning “to work as part of a team” whereas five statements relating to learning “what to expect as an engineer”.

<table>
<thead>
<tr>
<th>What was learned</th>
<th>Factor 1 – Problem Solvers</th>
<th>Factor 2 - Apprentices</th>
<th>Factor 3 - Doers</th>
<th>Factor 4 - Deciders</th>
</tr>
</thead>
<tbody>
<tr>
<td>to work as part of a team (3)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>to communicate effectively with others (5)</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>to find and solve problems (4)</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>the technical skills of my discipline (4)</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>about how I learn and how to learn from a variety of experiences (4)</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>more about what I really want to do with my career (4)</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>what to expect as an engineer (5)</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>how much I don't know (4)</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>how to manage conflicts or unexpected problems (5)</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>new skills that will help me be successful in the workplace (4)</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 7-8: Frequency counts for each "how" statement and its location in the representative factor Q-sort. Numbers in parentheses represented the total number of statements associated with each column or row. For example, there were nine statements relating to learning “by repeated practice in real-world situations on my team” whereas seven statements relating to learning “from my own successes and failures”.

<table>
<thead>
<tr>
<th>How that learning occurred</th>
<th>Factor 1 – Problem Solvers</th>
<th>Factor 2 - Apprentices</th>
<th>Factor 3 - Doers</th>
<th>Factor 4 - Deciders</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>2</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>by repeated practice in real-world situations on my team. (8)</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>when I reflected on my co-op experiences and thought about my learning. (8)</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>from my own successes and failures. (7)</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>after gaining responsibilities and becoming more integrated into the workplace. (10)</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>
7.4 Ungrouped Participants

After profiles of each group were developed and compared, I then qualitatively explored the participants that were not factored. I first reviewed the factor loadings of the ungrouped participants (Table 7-9) to get a sense of any combination of factors they may belong to. For example, Rudy has relatively similar loadings for both Factor 2 (Apprentices) and Factor 3 (Doers) so he may be more apt to use one method over another depending on the context. This additional analysis is not discussed by Q-Methodology references and this exploration is intended to extend the analysis of the four factors and identify any outlying perspectives.

Table 7-9: Table of factor loadings for just participants that did not load onto a single factor.

<table>
<thead>
<tr>
<th>Participant Number &amp; Pseudonym</th>
<th>Factor 1 – Problem Solvers</th>
<th>Factor 2 – Apprentices</th>
<th>Factor 3 – Doers</th>
<th>Factor 4 – Deciders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Andy</td>
<td>0.491</td>
<td>0.370</td>
<td>-0.239</td>
<td>-0.314</td>
</tr>
<tr>
<td>7 – Rudy</td>
<td>0.228</td>
<td>0.434</td>
<td>0.420</td>
<td>-0.126</td>
</tr>
<tr>
<td>16 – Ray</td>
<td>-0.062</td>
<td>0.245</td>
<td>0.350</td>
<td>0.261</td>
</tr>
<tr>
<td>18 – Jordan</td>
<td>0.291</td>
<td>0.390</td>
<td>0.270</td>
<td>0.161</td>
</tr>
<tr>
<td>23 – Ryan</td>
<td>0.453</td>
<td>0.427</td>
<td>0.256</td>
<td>0.387</td>
</tr>
<tr>
<td>28 – Blaine</td>
<td>0.388</td>
<td>0.411</td>
<td>-0.163</td>
<td>0.188</td>
</tr>
</tbody>
</table>

**Andy**

Andy worked as a quality co-op at a company that makes medical products and commonly required statistical analysis. Her co-op was heavily team-based, describing her co-op as “everything we did was kinda a team exercise.” The co-op program at the company was heavily structured and the co-op students were not provided much independence.
Coming into a co-op they don't expect you to know a whole lot, and they kind of treat you that way. So you're kind of kept out of really important things. And I worked as a quality co-op so we were involved in some high level, some real issues that was going on in the plant. And we weren't allowed to touch those because we didn't know the quality process yet. Especially in the beginning.

Andy struggled in her co-op because what she was doing was not anything that she expected to be doing as a bioengineer.

My major is bioengineering and I have an electrical concentration, so I was kind of expecting to be hands on, on the floor, working with machines, or at least working with the suture because we made sutures and other things but mainly sutures. What I found that I was doing instead was just Excel graphs, day in and day out. And statistical analysis. I haven't taken statistics since high school. So that was different. That was not what I was expecting.

The roles and daily tasks caused Andy to reflect heavily on whether she wanted to continue in bioengineering, explaining that the co-op confused her as to what to do for her career.

[All the disagree statements] are all the "learned more about what I really want to do in my career" because I got very confused after the co-op because I wasn't really enjoying what I was doing on the co-op... Because like I said it was nothing that I had learned in class. I thought maybe I should be doing something on the floor,
working with machines, working with biomaterials, but I wasn’t so that was pretty confusing for me. But I also was thinking is this what bioengineers normally go to industry to do? So, then I was like “Do I really want to be a bioengineer?” and so I thought about physical therapy and I was just all over the place. So, I was just very confused, and I put all of this on the disagree column.

She seemed distressed in the interview about her future career and worried she had selected the wrong major but was too far into the curriculum to make a change. When asked about what she wanted to do, she had a defined idea of where she wanted to go, but her co-op had a strong negative impact on her confidence in her ability.

I would love to work with medical equipment. I would like to be in a hospital troubleshooting medical equipment. But this co-op also taught me, and well, maybe I was just intimidated because there were so many really smart people that could do all this stuff that I realized well maybe I’m not so good at the technical side either. So I was very confused the whole time. And still am.

This confusion and distress about where she should go with her career could be why Andy negatively loads onto the Decider factor. Unlike the Deciders, the co-op made Andy question her career path and her abilities to perform well there.

Andy did solve a number of quality problems while she was on co-op but that experience could have been tempered by the oversight in the quality department. Because Andy ranks problem solving statements high, this could be why she has a high loading on
the Problem Solvers factor. Other participants in quality departments did discuss not having to find problems because quality was always working through problems; however, it is not clear from the interview if Andy sees the department as restrictive or the nature of the work is one where problems are given to you.

*Andy: This one, I learned to find and solve problems, not really in my co-op experience, because we were given problems and told how to solve them. It wasn't really a whole lot of initiative. Maybe that was just quality engineering. I don't know.*

*Interviewer: So less of the finding, and some of the solving?*

*Andy: Well they told you what to do, entirely.*

Again, Andy did discuss learning from her co-op through the Apprentice model of watch, mimic, emulate, and internalize; however, this also seemed tempered because of the rigid structure of the co-op at the company she worked for.

*[T]hey also tried to expose us to a variety of different engineering disciplines like process engineering and design engineering in addition to quality engineering, so that was good. We got to do a whole lot of different things. And there was something new always every single day. Because we were supposed to solve the problems as they came along. And then, yeah, I had a mentor when I was at [Company]. So, I basically followed him around and did whatever he wanted me to. So that was a really great learning experience.*
Andy does describe watching her mentor work and completing the tasks he assigned as a “really great learning experience” but that also means that she did not identify as strongly with the statements that ended in “from gaining responsibilities and becoming more integrated into the workplace” which limited her alignment with the Apprentice factor.

Andy does talk about learning on her co-op in her own words, describing skills that she refined including presenting skills and how to manage her own time but she describes learning these skills through repeated practice which would align with the Doer factor.

One huge part was presenting and running meetings, because we had to set up meetings. We had to then run those meetings and at the end we had giant presentations, sometimes in the middle we'd have presentations. And I used to hate presenting, and I still kind of hate talking in front of multiple people, but it's definitely gotten better and I feel like I can communicate better than I could before. Just by constantly having to do that every single day.... A lot about time management because we would, as quality engineers, we get busy when something goes wrong. We're lax when everything is running appropriately. It was hard not to sit at my computer and play games when it was super chill and not to get overwhelmed when we were really busy.
Rudy

Rudy worked as an industrial engineering co-op at a concrete company that poured prefabricated concrete for construction projects. He was treated like a full-time engineer from the beginning and he appreciated being treated that way.

"In my co-op I really got basically integrated into the IE team. My first rotation really, they didn't have specific co-op projects that were just set aside as the cookie cutter we want you to do a time study to learn how to do a time study, they kind of just really brought me in and was like here's what we're working on, can you help out with this? They would give me part of the project to work on and then as things arose I kind of just helped out where I could, and just did projects. So I was basically, I was almost an entry level engineer at the plant so I got to do a lot of the things that the other engineers were working on, like some of them had like big projects and hey had stuff that they otherwise would be working on. So they were projects that the entry level engineers actually are working on, that they pushed to the co-ops, so I felt like I was actually doing real engineer work. I wasn't just the intern with working on certain stuff on excel and stuff."

He had a variety of experiences and was asked to work several projects, but two of his more impactful experiences aligned with the Doer Factor and the Apprentice Factor. The first experience was Rudy was tasked, along with the other co-op, to plan a new building for the carpentry shop they had on site. The carpentry shop that was already there built the forms they used for the concrete and had outgrown its current location. Rudy and
the other co-op were asked to scope out a location on site where a new building could be made, interface with the carpenters to ensure the building suited their needs, and had to rework the process flow to incorporate the new building. He learned about how to work with multiple departments, plan out a building, and rework the process flow for a large manufacturing company, all through doing the work, aligning with the Doer factor.

*We came to the conclusion that our carpentry shop, which is there, needed space, and therefore needed to be relocated, and we came up with the idea to make a whole new building, and so they kind of tasked me and the other co-op with figuring out where it would go and figuring out the logistics of so where does it need to go, how's it going to affect the rest of the plant if we plop a building down in this area, what does it need and then we had to design the internal layout of it to make sure it flowed well. So I ended up having basically meetings with the carpentry shop people, the people that it would affect, and the senior level management, on pretty regular basis, talking with them and basically working as a team to collaborate and get a picture of where the best place to put it. Since we're building it from scratch, what's the best way to lay it out, what's going to work best for you guys who are going to be working in it. Is there anything else you need, since we're making it new, that we can improve on and basically just learning how to work with different people on a team to kind of make this new thing come to life.*

However, another critical experience for Rudy is that he was allowed to sit in on a weekly corporate update meeting. In that meeting he learned about how the other plants
were performing, if there were any concerns related to productivity or safety by watching, much like the participants in the Apprentice factor.

I was able to sit in on their weekly basically update meeting, they would go over safety, how everything was doing in the plant, across the other plants, we had people from our corporate plant is located at our [branch location] plant. So I was able to sit in with not only the people from the local plant but the corporate people and they would go over all these things and of course there's problems, maybe there's a safety problem, or maybe we're behind on this project or whatever different things clashing, people would obviously have conflicts between their own department because they're looking out for themselves but they're also looking out for the projects. So I was able to observe conflicts and how they were addressed, talked about and resolved, in those meetings because they were mainly supervisors and upper level management people who would talk about big picture projects and scheduling and problems that were going on not only in our plant but at our job sites across the Eastern Seaboard.

Here, Rudy becomes more of an apprentice, learning through observing and internalizing the behavior of others. Although he does not report having interpersonal conflicts, he watches how major conflicts and issues are addressed from company leaders, much like how Tyler and many of the other Apprentices approach their roles. However, Rudy confirms that he also learned through doing and taking charge of a project.

So a lot of it was just I was on the floor with the senior guy and he was telling me how things worked with my mentor telling me how things worked, the process,
asking a lot of questions, sitting in on those meetings definitely helped, via the
projects I had to work with different people and I learned kind of like what their
responsibilities were and how they interacted with the IE team, so definitely via the
projects, asking questions and just kind of being thrown in the deep end first.

Ray

Ray is an industrial engineer and worked in the quality department at an automotive
manufacturing plant. His department was responsible for both in-house quality (ensuring
the product is manufactured and assembled correctly) as well as out of house quality
(determining why a product failed in the field). Ray described his supervision as limited
and appreciated that freedom to explore the quality space.

At least at my company, this is probably specific to them, but it's extremely hands
off. I have a mentor. I have a manager, and people I always know that I can consult
with, but you are not micromanaged one bit. A lot of the times, you find and solve
problems on your own, and you learn to just talk, go out of your department to talk
to other co-ops, and sometimes it's like, "What are you working on?" stuff like that.
That would happen very often. Especially integrated into the workplace, as my
rotations went on, I felt more comfortable. Learning to find and solve problems
would be a third of what I did.

Ray learns through the act of doing and gaining responsibilities, aligning with the
Doer factor. One of his highest ranked cards was learning “to find and solve problems after
gaining responsibilities” which he contrasted with the card he strongly disagreed with: “to find and solve problems by watching the engineers at my company.”

[The card saying] "I learned to find and solve problems by watching the engineers at my company do what they do." This one is actually juxtaposed with one over here, which was, the find and solve... Yeah, yeah. That was becoming more integrated. This one is watching people do what they do. I just didn't. I learn to find and solve problems by working with other co-ops mostly. The people that were my mentor, and the people that were full time in my department, they didn't really find and solve problems. They had a very specific job and had no time to do anything else, but their specific job, which was not to find and solve problems. It was so I could address certain things. It was because the co-ops had extra time. We were like, "Okay, let's go find and solve problems." It was not because of watching what full time people do.

Ray also has alignment with the Decider factor. He consistently reflects on whether he wants to return to the company as a full-time engineer or perform the same duties at another company.

I strongly agree with this, because that is the biggest way I'm currently deciding if I want to do that or not as a full time job, is just by thinking about how the type of lifestyle that the full time employees there lived already, instead of thinking about my job specifically that I did there. I know my job would change if I went there full-time. I'm just thinking about, "Okay, what if I was my mentor? Would I be happy or
not?" That's what I'm thinking about day to day now. That's why I put that one there... Our department was responsibility for quality in our plant, but also quality once the product left the plant. There'd be sometimes where would get reports that something was wrong in the field. Because it's safety critical, there would be times where you'd have to, or at least my mentor and people I worked with, would have to come in over weekends, Saturday, Sunday, and they'd stay late into the night, and stuff like that. There was a specific case of when these things happened. My mentor was there for 24 hours. That weighs on my decision. No one really wants to do that, stay there that long and stuff.

**Jordan**

Jordan worked as a mechanical engineer, supporting the manufacturing process. He developed friendships with the line operators and so when he would check on the progress of a project or get feedback from a design he had implemented, he would often get commentary and a few additional projects to work on.

*On my third rotation, I knew everyone that worked on the floor pretty well. So, I would go down there to check into on the fixture I was testing, and while I was there I'd be talking to different workers, and they would give me different tasks or different things that they had difficult going on in their own stations, and I would make it one of my projects... Almost every time I went to talk to someone on the floor, I got two or three more projects in return.*
Although Jordan’s loadings indicate that his views may align most with the Apprentice factor, it is mostly because of the value he sees in watching the engineers and learning from them. However, he described his learning experience more in ways that align with the Problem Solver factor.

The biggest thing was what I talked about before with being able to solve problems and different ways of looking at solving a problem. Never being limited, being very flexible. Getting a better idea of what engineers actually do day to day, by watching them and working closely with them. An extension of that was realizing more, what I was interested in and what I specifically did not want to be doing... Also, just being able to work completely on my own in terms of, if a problem pops up there's no one to help me and I need to be able to figure this out on my own. 'Cause that's just what's expected of me.

Much of his role was in find and solving problems and he developed strong problem-solving skills, especially on becoming flexible with his approach and willing to adapt to a solution as more information comes to light.

The biggest [skill I learned] would be thinking about how to solve a problem because if somebody told me they wanted a problem solved, and they wanted this solution A ... My first summer there I'd be hitting my head against it, trying to figure out how to solve it with that solution. It was way later that I started ... Once you're presented with a problem to not think on having a single solution and be thinking of a variety of ways you can solve it, and never be fixed on a specific one.
I had a lot of problems when I first started. Just, trying to think of a single solution and it not working out. Trying something and as soon as it doesn't work, immediately being willing to try something else or be willing to break something in order to repair it.

**Ryan**

Ryan is a mechanical engineer and his projects were focused on either “testing or development of designs for the company’s products.” Observing Ryan’s factor loadings, he has relatively equal factor loadings across all four factors, indicating that he moderately agreed with all four viewpoints. Ryan described that an important skill he developed was how to best approach solving a problem which he learned through gaining responsibilities and his own successes and failures from trying to solve the problems, aligning with the Problem Solver factor.

I felt like [the company I co-oped for] gave me a lot of responsibilities where I had to make a lot of decisions, and I had to solve a lot of problems. And as I gained more responsibility though working with them, the problems got a little tougher, or a little less cut and dry, and so it helped me identify what are the best ways to evaluate a good solution to a problem...Because in the successes and in the failures that I had on co-op, being able to identify something as a problem that I didn't see as a problem beforehand, or identify a bad... not necessarily a bad decision, but a poor decision at the time, in terms of timing or being able to complete it in a good way, or something along those lines.
To Ryan, a critical step in the design process was design documentation. Ryan learned that skill from watching and emulating how the engineers would approach documentation.

*I think I gained a lot of good documentation practices, good organizational things, especially in a long, long going project. Watching them and how they organize, and how they use the company's organizational strategies and apply their own twist on it, just so they can see it mentally, but they also know that the company has to be able to find it, was good to help me integrate how I organize things with whatever company I end up with after graduation.*

While Ryan did learn from watching the engineers and modelling that behavior, he also learned through being immersed in the process of design.

*Interviewer: How do you think you learned those things?*

*Ryan: Just by the projects I was put on... And so those projects that I was on allowed me to see the different aspects of the design process. Coming up with the idea, what you need to do is we were given a co-op where we needed to come up with something, and then bring it through the process that they have at [Company]. From idea inception to getting initial drawings, and making sure you have all the documentation you need in the beginning steps, and then prototyping and starting to prototype, and then from there testing, and from testing, if you need
to recycle and fix something, if not you can go to implementation. Just the design process in industry, based on the projects I was put on, is probably how I learned most of that stuff.

Ryan’s equal loading indicates that his views on his learning were moderate relative to the factors. In the interview, Ryan struggles to decide on specific ways that learning could occur which is why he cross loads onto the Apprentice and Doer factors. He is confident that he has learned skills, especially design skills, but is unsure if there was a single way he learned those skills, attributing the development to both types of learning.

Interviewer: Are there other cards that you agree with, that really reminded you of particular instances on your co-op?

Ryan: Probably something to do with technical skills of my discipline, of engineering. I can't decide if it's more watching the other engineers in the company, or from what I've done, and what I've been told after it's been submitted to be checked, that it's good or needs to be changed. I can't really pick between those two, it's one of those two.

Lastly, from Ryan’s co-op, he does refine his understanding of the career path he wants to take. This aligns well with the Deciders. Ryan builds an understanding of what it means to be a design engineer and feels more confident in the role he desires to have when he completes his degree.
I knew I wanted to go into some sort of design role, but I didn't know what kind of design, what kind of... would it only be design, or would be testing as well? And as I've gone through two rotations, I've done one kind of design, it wasn't new products, but it was a design role, and then one testing role. And both were super enjoyable, and kind of made me realize that I want to go into a role that's kind of a mix of designing a thing and then testing it, or essentially taking it all the way through from idea generation to being at the product line. So, not just sitting behind a computer, but not just super hands-on.

Blaine

Blaine “worked with research and design: including testing products using robots, designing parts for prototypes, and helping to save money in different areas such as transportation and materials.” One critical aspect of Blaine’s co-op experience was seeing the lifestyle that the engineers had and wanting to avoid that lifestyle. He sees the engineers at the company he worked for as internalizing a significant amount of pressure and stress because of the job and he does not want to fall into that trap. Like the Deciders, Blaine is seeing how full-time engineers operate, envisioning his future career from those observations. However, unlike the Deciders, Blane did not consider specific roles or responsibilities he desired to seek or avoid, but more about the approach to work in general.

Seeing some engineers in their state makes me not want to do what they're doing more so than the other way around I think. So, “On co-op, I learned what to expect as an engineer by watching the engineers in my company doing what they do”. I
think from this, watching what they do, I can see what being an engineer is probably going to be like, not going back to what I said about the specific engineers. Just this is more, I think stress got to a lot of engineers a lot. And that was, I don't want that at all. I don't know, but other engineers at where I work, you could definitely tell that that's what an engineer is like... I learned more about what I want to do by my career, but seeing and avoiding the pitfalls of getting caught up in "I have to get this done by now" and "this is going to be the end of the world." But in reality, it's probably going to be okay... The phrases that probably stood out were what I wanted to do with my career. The different ones there. Just who thought what I learned from watching the engineers. But then I also wonder if I'm just gaining responsibility and started to feel that stress myself coming on at times. So I was like okay, I might not want to... At least be weary of that in the career path that I choose.

Like the Problem Solvers, Blaine developed metacognitive skills, but in areas that are less tied directly to solving problems. Because the engineers talked with Blaine about the technical content that is driving their work, he started to appreciate his coursework more and changed his motivations to learning the material from “to get a good grade” to “so I am prepared for my career” which positively impacted his academic performance.

I learned [how important the things taught in class are] after my first rotation [and I approached] school in kind of a different way. Because I started to see things as "I need to learn this for my career” rather than "okay I could get a good grade." And my grades were really good last semester so, I guess it was a good way to look
at it. But I don't know, it was weird that I was not trying to get good grades. I was focusing on more of the importance to learn this stuff for my career and my grades actually, this was the best semester I've had.

He also sees how iterations on a project can help make it better, but that it will never be perfect.

*I think I've learned to live with my mistakes, and learn from them just because I've definitely made some mistakes... I literally had a 3D printed part that I made three iterations of and each time there was something wrong with it and I was like "Okay, make another one. Okay, make another one." I finally got one that was pretty good, but there still could be improvements about it. So I guess I also learned that nothing can be exactly perfect. There's always room for improvement.*

Blaine is embracing the imperfect nature of engineering in industry and becoming more comfortable with what the design needs to do to complete a project and move forward.

Blaine is one of the few co-op students that talk about learning while working on a team. Many of the other students did learn through their interactions with others but few attributed it to a formal team like Blaine.

*Working on the team. We have a huge co-op project that we all worked together on, and there's quite a few co-ops where I work. So, we all have kind of a tight knit bond and we've learned to communicate. If we disagree with something, we know how to communicate to each other because we know each other so well that we can*
say it in a way that's not going to offend anybody, but still get our point across and what we think should be the case, that kind of thing.

The interactions on his team make him more open to different perspectives or ideas. Blaine begins to see how he should not shut out an idea completely because he sees a flaw in one facet of the idea, instead work to improve that facet so that it will be successful.

Learn to hear other people's ideas a little better. So I think at times before my co-op, I would hear ideas and just kind of shut them off right from the beginning if I heard something that I didn't agree with instead to hear the rest of it out because a lot of the times, especially with a co-op project I learned that's a really good idea actually, I just didn't really agree with the first part, let's change the first part around maybe a little bit and then I agree the second part. [I learned that through] communication, having to work in a team, working alongside of engineers... senior engineers.

Blaine values being able to watch and interact with the other engineers in his company. These interactions have a significant influence on how Blaine sees engineering, the goals he has on his career mentality, and how to approach his coursework which is why he has some alignment with the Apprentice factor. Blaine’s understanding of the role of knowledge plays in his future career as well as ways for him to gain more knowledge align with the metacognitive skills that are developed in the Problem Solver factor; however, he does not attribute learning these skills through problem solving which is likely why he weakly loads onto that factor.
7.5 Triangulation

Throughout the study, there were multiple instances where I evaluated the same data through both qualitative and quantitative lenses. Using the two lenses allowed me to support my analysis in multiple ways. For example, after completing the more quantitative factor analysis, I explored the data qualitatively. After coding all the transcripts in the Apprentice factor, I made a note stating that Tyler seemed to be the most representative of the group while Campbell seemed to be qualitatively distant. The quantitative results confirm this qualitative observation. While Tyler had a factor loading of 0.808 which indicates an extremely central view, Campbell’s loading was 0.569 which is a more moderate loading.

The Decider factor supports this as well. Devin’s factor loading was 0.703, indicating a strong alignment with the factor view, Julian and Dale do not have dramatically different loadings (0.696 and 0.644, respectively). All three participants had made a final decision on what they wanted to do and had a defined plan on how to reach those goals. West, the only participant in the factor who had not decided exactly what he wanted to do, also had the lowest loading (0.535), indicating the weakest alignment with the factor view.
CHAPTER 8: CONCLUSIONS

This study formally and systematically documented student perspectives of what skills and knowledge were learned and how that learning occurred on co-op. My research question was “What are the different ways students perceive what and how they learned on co-op?” I answered this question by leveraging the Q-Methodology and determined four unique viewpoints about learning on co-op with 22 of the 28 participants being factored into one of four viewpoints. The four factors were named: The Problem Solvers, The Apprentices, The Doers, and The Deciders which describe their central views on what was learned or how that learning occurred. The remaining six participants expressed views that aligned with more than one of the four groups.

Two of the four factors aligned more with what was learned on co-op (The Problem Solvers and The Deciders) while the other two groups focused on how that learning occurred (The Apprentices and The Doers), with strong qualitative and quantitative consensus. Additionally, each factor aligned strongly with one of the four theories incorporated in the study with the Problem Solver factor aligning most with the theory of metacognition, the Apprentice factor aligning with Lave and Wenger’s Situated Learning Theory, the Doer factor with Kolb’s Experiential Learning Theory, and the Decider factor with Social Cognitive Career Theory.
After reflecting on the results of this study and the alignment between the factors and all four theories, I have developed a more nuanced understanding of the relationship between the theories and the co-op experience (Figure 8-1). Students have pre-co-op experiences that can inform the constructs within Social Cognitive Career Theory (SCCT) and can weakly build metacognitive practices, skills, or knowledge.

Then students participate in co-op which can be described by both Kolb’s Experiential Learning Theory (ELT) and Lave & Wenger’s Situated Learning. ELT tends to be more descriptive of how the students built their knowledge and skills day-to-day and week-to-week. As students continued in their co-op, they would continue through cycles of ELT growing their knowledge and understanding over time which is indicated by the white spiral in the ELT box. Situated learning was a better theory to describe the student’s trajectory through their full co-op rotation. The student would start out initially on the periphery and as they gained more responsibilities and were recognized by established members in their community of practice (defined as their workplace), students would build skills and knowledge. The Lave & Wenger box has a gradient to indicate this integration. These two theories do not operate in isolation to each other. While a student could learn skills through ELT, it is through the social interactions that the student gains necessary feedback and credibility to that developed knowledge.

The co-op experience has a significant influence on career decisions and impacts many of the constructs described in SCCT like outcome expectations, interest, goals, and self-efficacy. Students in this study describe how being exposed to the daily responsibilities of an engineer helped them refine their understanding of what it meant to be an engineer.
or to be an engineer with a specific role (software development, quality, construction management, etc.). This exposure helped students calibrate and refine those outcome expectations, adjusting their career goals based on their co-op experiences.

Students in this study also described how their approach to their courses, what they counted as knowledge, and their motivations to learn were impacted because of their co-op experience. I posit that much of these metacognitive gains are due to students being asked to be metacognitive. Metacognition is not often fostered in classrooms because many assessments are closed-ended, only having one solution to a problem. However, much of engineering work in industry is inherently metacognitive. In industry, engineers are exposed to open-ended problems which have multiple solutions. For example, engineers could be asked to identify or define problems, develop metrics to determine if the problem has been solved, implement evaluation processes, critically analyze solutions, and prioritize performance or production needs. Because students are asked to perform tasks that require metacognition, they develop it through their co-op.

Once students return to their coursework, those new experiences continue to influence SCCT constructs and metacognition, but not as strongly as the co-op experience did; however, metacognition has a strong impact on the student and their approach to their work. Students who participate in another co-op rotation after a semester of coursework repeat the cycle as indicated by the arrow connecting “Post Co-op” with “Pre-Co-op”. After the cycle of co-op rotations are complete, students graduate and continue with their career. While SCCT does continue to influence the career choices a person makes, their career will continue to also influence metacognition and metacognition will have an influence on the
person’s career. Each factor identified in this study is also included in the appropriate location.
Figure 8-1: Model relating the four theories used in the study and how they connect to the co-op experience.
8.1 Implications

Most importantly the model depicting the relationships between four critical theories in co-op research (Figure 8-1) deepens the understanding of each theory and how they explain parts of the co-op experience. Since each factor mapped to one of the four theories used in this study, this indicates a need for researchers to embrace a broader lens of learning on co-op or understand the limitations of a study that relies on only one theory.

Some participants in this study shared that there was limited connection between their coursework and their co-op experiences, especially the computer engineering majors and the participants with roles in quality. The participants majoring in computer engineering expressed how they felt underprepared in their co-op because they were not familiar with object-oriented programming languages. The participants observed that companies need computer engineering students who have knowledge in object-oriented programming, but the students were not exposed to this programming paradigm in their computer engineering curriculum. Computer engineering educators could consider addressing this topic in existing courses or encouraging their students to enroll in object-oriented coursework as technical electives to help build skills that are currently in demand in industry.

Mechanical and industrial engineering students with co-op positions in quality also struggled to connect their coursework to their co-op experiences. Educators in these fields could consider ways they can incorporate a broader exposure to quality concepts in the curriculum. This could include creating assignments that require students to apply concepts
discussed in class through a quality lens and reimagining courses in the curriculum to be more quality focused.

The results of this study can help co-op administrators, students, and industry mentors construct a shared language and understanding of each other’s needs. Co-op administrators play a central role in sharing and communicating that language. Leveraging the results of this study, co-op administrators can help guide both students and mentors in building a more effective co-op experience. On the student side, administrators can share these results to help students identify their own learning needs. Once a student can identify their learning needs, they can focus their searches at companies or positions that can best serve those needs. Additionally, this knowledge can positively benefit the co-op process after placement as students can more confidently navigate the workplace.

Co-op mentors can leverage these results to help them foster opportunities for dialogue and discussion with their co-op mentees. Discussing learning needs early in the co-op experience can help ensure expectations of each member (student, mentor, other co-workers) are defined and made clear.

8.2 Limitations

As with any study, there are limitations to my work. A limitation of Q is that it does not provide an exhaustive list of the perceptions of learning while on co-op for students; it only provides groupings of those that participate in the study. While I was able to recruit a wide range of majors and co-op roles in my study, there were few students from minoritized racial populations who participated in the survey and ultimately only students who identified as White or Asian completed interviews. As this study is documenting
perceptions of learning, having a wide range of viewpoints would only strengthen the value of this study and could extend the breadth of perspectives documented. Diversity of the co-op experience matters, but diversity of the participants does as well. Having a predominately White participant sample can perpetuate normative experiences and unintentionally diminish the voices of already minoritized individuals. Main, Johnson, Ramirez, Ebrahiminejad, Ohland, and Groll [74] noted that underrepresented or racially minoritized populations (URM) were less likely to participate in co-op. Purposefully documenting these voices might positively influence more URM students to participate in co-op which has many documented benefits. The Q-Methodology is not intended to be generalizable but is intended to be more generalizable than traditional qualitative methods. Q can only identify the unique views of the participants within the sample and therefore has limited scope if the sample is not sufficiently broad.

Students who had bad or traumatic experiences may not be as willing to participate and relive that negative experience. Although my study did have participants that did not praise their experience (i.e. Devin and Andy), they also did not state that they were victims of hazing, harassment, abuse, or other traumatic experiences while on co-op. As such, the negative views expressed were limited and mild.

8.3 Future Work

The first avenue for exploration in future work is to extend the diversity of the participant pool. I will do this by collaborating with co-op administrators to redistribute the invitation to participate in the Q-sorting process and follow up interview with an intentional
focus on expanding the diversity of my participants. This will be done with the existing statements so that this new data can be merged with the data discussed in this study.

Beyond adding to the diversity of my participants, I would also like to expand this study to explore the impact the institution may play in student views. I would like to seek participation from multiple US institutions with a range of co-op program structures. Some US institutions require their engineering students to complete multiple co-op rotations as a graduation requirement. Students at these institutions may have different views because the co-op experience is more actively embedded into their curriculum. Johnston et al. [26] documented a student group that saw that the co-op structure provided no additional value to the student. Because the institution of study does not require co-op participation for graduation, this group, or others like it, may not be present in my initial sample.

Before extending my data collection beyond a single institution, I will review and modify the current set of statements. First, I will directly map every what learned to every how. I removed some statements to reduce the number of statements, but upon review of the data, the factors may be more differentiated if the full connection of what and how were mapped to each other. I made this decision to reduce the number of statements and therefore mental load on the participants, but upon review of the data, I do not believe the additional statements would overload the participants.

I also plan on adjusting the reflection statement. The intent of the reflection statement was to map the reflection process noted in ELT; however, reflection was often interpreted as a “structured and formal way to think back and reflect on the whole experience.” This interpretation directly influences the location of the statements and
therefore the results of the study. In future iterations, the word “reflection” will be removed from the statements and replaced with a less formal action.

Additional research should be conducted in evaluating how the structure of the work environment impacts student learning and gains. Many of the participants in this study discuss how the structure, or lack thereof, of their co-op experience influenced what they learned. Better understanding how the structure influences learning and ways to build structure that will foster growth is a critical area of research.

New research should also better explore how students can gain metacognitive skills through the identification, scoping, and solving of problems. Students in the Problem Solver factor show how being asked to build these problem-solving skills in a less structured environment had impacts on their metacognition and their approach to their coursework when they returned to school. Additionally, building these metacognitive skills can positively impact student motivation and career decisions.
<table>
<thead>
<tr>
<th>What is learned</th>
<th>How learning occurs</th>
<th>to work as part of a team</th>
<th>to communicate effectively with others</th>
<th>to find and solve problems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned to work as part of a team by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned to communicate effectively with others by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned to find and solve problems by watching the engineers in my company and doing what they do.</td>
</tr>
<tr>
<td></td>
<td>by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned to work as part of a team by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned to communicate effectively with others by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned to find and solve problems by repeated practice in real-world situations on my team.</td>
</tr>
<tr>
<td></td>
<td>when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned to work as part of a team when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned to communicate effectively with others when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned to find and solve problems when I reflected on my co-op experiences and thought about my learning.</td>
</tr>
<tr>
<td></td>
<td>from my own successes and failures.</td>
<td>On co-op, I learned to work as part of a team from my own successes and failures.</td>
<td>On co-op, I learned to communicate effectively with others from my own successes and failures.</td>
<td>On co-op, I learned to find and solve problems from my own successes and failures.</td>
</tr>
<tr>
<td></td>
<td>after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>On co-op, I learned to work as part of a team after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>On co-op, I learned to communicate effectively with others after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>On co-op, I learned to find and solve problems after gaining responsibilities and becoming more integrated into the workplace.</td>
</tr>
<tr>
<td>the technical skills of my discipline</td>
<td>On co-op, I learned the technical skills of my discipline by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned the technical skills of my discipline by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned the technical skills of my discipline when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned the technical skills of my discipline from my own successes and failures.</td>
</tr>
<tr>
<td>about how I learn and how to learn from a variety of experiences</td>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences from my own successes and failures.</td>
</tr>
<tr>
<td>more about what I really want to do with my career</td>
<td>On co-op, I learned more about what I really want to do with my career by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned more about what I really want to do with my career by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned more about what I really want to do with my career when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned more about what I really want to do with my career from my own successes and failures.</td>
</tr>
<tr>
<td>what to expect as an engineer</td>
<td>On co-op, I learned what to expect as an engineer by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned what to expect as an engineer by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned what to expect as an engineer when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned what to expect as an engineer from my own successes and failures.</td>
</tr>
<tr>
<td>how much I don't know</td>
<td>On co-op, I learned how much I don't know by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned how much I don't know by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned how much I don't know when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned how much I don't know from my own successes and failures.</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>who to connect with when I graduate</td>
<td>On co-op, I learned who to connect with when I graduate by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned who to connect with when I graduate by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned who to connect with when I graduate when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned who to connect with when I graduate from my own successes and failures.</td>
</tr>
<tr>
<td>how to manage conflicts or unexpected problems</td>
<td>On co-op, I learned how to manage conflicts or unexpected problems by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned how to manage conflicts or unexpected problems by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned how to manage conflicts or unexpected problems when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned how to manage conflicts or unexpected problems from my own successes and failures.</td>
</tr>
<tr>
<td>new skills that will help me be successful in the workplace</td>
<td>On co-op, I learned new skills that will help me be successful in the workplace by watching the engineers in my company and doing what they do.</td>
<td>On co-op, I learned new skills that will help me be successful in the workplace by repeated practice in real-world situations on my team.</td>
<td>On co-op, I learned new skills that will help me be successful in the workplace when I reflected on my co-op experiences and thought about my learning.</td>
<td>On co-op, I learned new skills that will help me be successful in the workplace from my own successes and failures.</td>
</tr>
</tbody>
</table>
Email Invitation to Participate in Initial Survey

Subject: Cooperative Education Program - Research Participation Opportunity for Co-op Students

You are invited to participate in a research study documenting undergraduate engineering students’ experiences in the Cooperative Education Program. We are studying this using a survey and a follow up interview. You are invited to complete the survey below which asks about your co-op experiences, academic and demographic background, and whether you are interested in participating in a follow-up interview.

The results of this study will be used to begin understanding how students view their co-op experiences and how these experiences affect future academics. We would greatly appreciate your participation, as your perspective on co-op is valuable to this study. Students who complete the survey and are invited and participate in a follow-up interview will receive $25 (Amazon Card) for their time.

To complete the survey, please follow the link below.
https://goo.gl/forms/yfeqqeZIwto3dmpU2

This survey will be open starting today and will remain open until Wednesday, April 10th when students will begin to receive invitations to interviews.

Thank you!
Email Invitation to Participate in Interview

Subject: You are invited to participate in an interview on your co-op experiences

Hello [Name]

Thank you for completing the survey about your co-op experiences. I have a few more spaces left for interviews and was hoping you were still around Clemson and available for an interview. This work will help us better understand your co-op experience and contribute to my PhD research. The interview will take approximately 1 hour and to thank you for your time, you will be provided a $25 Digital Amazon Card. Interviews will need to be completed by Wednesday, May 22nd, but I'm available most weekdays through the evenings. If you are interested in participating and can't find a time that works with both of our schedules, please email me and I'll see what I can do to make it work.

The results of this study will be used to begin understanding how students view their co-op experiences and to inform future co-op programs. I would greatly appreciate your participation, as your perspective on co-op is valuable to this study. I am not affiliated with the Clemson Co-op Program and will only present a summary of analysis without any of your identifying information.

To sign up for an interview, please follow the link below. Details on the location of the interview will be provided in your confirmation email.

https://kehlert.youcanbook.me/

Kathy Ehlert
--
Katherine M. Ehlert, MS
PhD Candidate
Graduate Research Assistant
Department of Engineering and Science Education
M-10 Holtzendorff Hall
kehlert@g.clemson.edu
APPENDIX C: Interview Questions

1. Before we begin, can I get you to describe how strongly you agree or disagree with each one of these columns? I would like to get an understanding of your scale.

2. Why did you place these three statements in the “Strongly Agree” category?
   a. If you had an extra spot in this category, would you add another? Which one and why?
   b. Are there parts of your experience that influence you on selecting these statements?

3. Why did you place these three statements in the “Strongly Disagree” category?
   a. If you had an extra spot in this category, would you add another? Which one and why?
   b. Are there parts of your experience that influence you on selecting these statements?

4. Talk about the statements you put in the middle… why did you put them there?

5. Were there statements that you struggled with sorting? What about the statement caused the struggle?

6. Are there any statements that you wanted to skip or that you felt were inaccurate in some way? Would you make any wording changes to any of the statements here?

7. Am I missing any statements? Is there something about your experience that you don’t think is reflected in these statements?

8. This study is looking at learning on co-op. Can you describe what you learned and how you learned it in your own words?
<table>
<thead>
<tr>
<th>Statement Number</th>
<th>Statement</th>
<th>Three Word Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>how-learn-responsibilities</td>
</tr>
<tr>
<td>2</td>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences by repeated practice in real-world situations on my team.</td>
<td>how-learn-practice</td>
</tr>
<tr>
<td>3</td>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences by watching the engineers in my company and doing what they do.</td>
<td>how-learn-watching</td>
</tr>
<tr>
<td>4</td>
<td>On co-op, I learned about how I learn and how to learn from a variety of experiences when I reflected on my co-op experiences and thought about my learning.</td>
<td>how-learn-reflection</td>
</tr>
<tr>
<td>5</td>
<td>On co-op, I learned how much I don't know after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>dont-know-responsibilities</td>
</tr>
<tr>
<td>6</td>
<td>On co-op, I learned how much I don't know by repeated practice in real-world situations on my team.</td>
<td>dont-know-practice</td>
</tr>
<tr>
<td>7</td>
<td>On co-op, I learned how much I don't know by watching the engineers in my company and doing what they do.</td>
<td>dont-know-watching</td>
</tr>
<tr>
<td>8</td>
<td>On co-op, I learned how much I don't know when I reflected on my co-op experiences and thought about my learning.</td>
<td>dont-know-reflection</td>
</tr>
<tr>
<td>9</td>
<td>On co-op, I learned how to manage conflicts or unexpected problems after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>manage-conflicts-responsibilities</td>
</tr>
<tr>
<td>10</td>
<td>On co-op, I learned how to manage conflicts or unexpected problems by repeated practice in real-world situations on my team.</td>
<td>manage-conflicts-practice</td>
</tr>
<tr>
<td>11</td>
<td>On co-op, I learned how to manage conflicts or unexpected problems by watching the engineers in my company and doing what they do.</td>
<td>manage-conflicts-watching</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>12</td>
<td>On co-op, I learned how to manage conflicts or unexpected problems from my own successes and failures.</td>
<td>manage-conflicts-success</td>
</tr>
<tr>
<td>13</td>
<td>On co-op, I learned how to manage conflicts or unexpected problems when I reflected on my co-op experiences and thought about my learning.</td>
<td>manage-conflicts-reflection</td>
</tr>
<tr>
<td>14</td>
<td>On co-op, I learned more about what I really want to do with my career after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>want-career-responsibilities</td>
</tr>
<tr>
<td>15</td>
<td>On co-op, I learned more about what I really want to do with my career by repeated practice in real-world situations on my team.</td>
<td>want-career-practice</td>
</tr>
<tr>
<td>16</td>
<td>On co-op, I learned more about what I really want to do with my career by watching the engineers in my company and doing what they do.</td>
<td>want-career-watching</td>
</tr>
<tr>
<td>17</td>
<td>On co-op, I learned more about what I really want to do with my career when I reflected on my co-op experiences and thought about my learning.</td>
<td>want-career-reflection</td>
</tr>
<tr>
<td>18</td>
<td>On co-op, I learned new skills that will help me be successful in the workplace after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>work-skills-responsibilities</td>
</tr>
<tr>
<td>19</td>
<td>On co-op, I learned new skills that will help me be successful in the workplace by repeated practice in real-world situations on my team.</td>
<td>work-skills-practice</td>
</tr>
<tr>
<td>20</td>
<td>On co-op, I learned new skills that will help me be successful in the workplace by watching the engineers in my company and doing what they do.</td>
<td>work-skills-watching</td>
</tr>
<tr>
<td>21</td>
<td>On co-op, I learned new skills that will help me be successful in the workplace from my own successes and failures.</td>
<td>work-skills-success</td>
</tr>
<tr>
<td>22</td>
<td>On co-op, I learned the technical skills of my discipline after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>tech-skills-responsibilities</td>
</tr>
<tr>
<td>23</td>
<td>On co-op, I learned the technical skills of my discipline by repeated practice in real-world situations on my team.</td>
<td>tech-skills-practice</td>
</tr>
<tr>
<td></td>
<td>On co-op, I learned the technical skills of my discipline by watching the engineers in my company and doing what they do.</td>
<td>tech-skills-watching</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>25</td>
<td>On co-op, I learned the technical skills of my discipline from my own successes and failures.</td>
<td>tech-skills-success</td>
</tr>
<tr>
<td>26</td>
<td>On co-op, I learned to communicate effectively with others after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>communicate-well-responsibilities</td>
</tr>
<tr>
<td>27</td>
<td>On co-op, I learned to communicate effectively with others by repeated practice in real-world situations on my team.</td>
<td>communicate-well-practice</td>
</tr>
<tr>
<td>28</td>
<td>On co-op, I learned to communicate effectively with others by watching the engineers in my company and doing what they do.</td>
<td>communicate-well-watching</td>
</tr>
<tr>
<td>29</td>
<td>On co-op, I learned to communicate effectively with others from my own successes and failures.</td>
<td>communicate-well-success</td>
</tr>
<tr>
<td>30</td>
<td>On co-op, I learned to communicate effectively with others when I reflected on my co-op experiences and thought about my learning.</td>
<td>communicate-well-reflection</td>
</tr>
<tr>
<td>31</td>
<td>On co-op, I learned to find and solve problems after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>find-solve-responsibilities</td>
</tr>
<tr>
<td>32</td>
<td>On co-op, I learned to find and solve problems by watching the engineers in my company and doing what they do.</td>
<td>find-solve-watching</td>
</tr>
<tr>
<td>33</td>
<td>On co-op, I learned to find and solve problems from my own successes and failures.</td>
<td>find-solve-success</td>
</tr>
<tr>
<td>34</td>
<td>On co-op, I learned to find and solve problems when I reflected on my co-op experiences and thought about my learning.</td>
<td>find-solve-reflection</td>
</tr>
<tr>
<td>35</td>
<td>On co-op, I learned to work as part of a team after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>team-skills-responsibilities</td>
</tr>
<tr>
<td>36</td>
<td>On co-op, I learned to work as part of a team from my own successes and failures.</td>
<td>team-skills-success</td>
</tr>
<tr>
<td>37</td>
<td>On co-op, I learned to work as part of a team when I reflected on my co-op experiences and thought about my learning.</td>
<td>team-skills-reflection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>38</td>
<td>On co-op, I learned what to expect as an engineer after gaining responsibilities and becoming more integrated into the workplace.</td>
<td>expect-engineer-responsibilities</td>
</tr>
<tr>
<td>39</td>
<td>On co-op, I learned what to expect as an engineer by repeated practice in real-world situations on my team.</td>
<td>expect-engineer-practice</td>
</tr>
<tr>
<td>40</td>
<td>On co-op, I learned what to expect as an engineer by watching the engineers in my company and doing what they do.</td>
<td>expect-engineer-watching</td>
</tr>
<tr>
<td>41</td>
<td>On co-op, I learned what to expect as an engineer from my own successes and failures.</td>
<td>expect-engineer-success</td>
</tr>
<tr>
<td>42</td>
<td>On co-op, I learned what to expect as an engineer when I reflected on my co-op experiences and thought about my learning.</td>
<td>expect-engineer-reflection</td>
</tr>
</tbody>
</table>
APPENDIX E: Visuals of the Factor and Individual Sorts

The visuals are organized by factor and then in numerical order of the participants. The bolded boxes in each sort identify the distinguishing statements for each factor. Those bolded boxes are then carried through for all the participants within the factor.
Factor 1: Problem Solvers

10 – Charlie

The diagram shows a distribution of factors and their associated scores. The factors are arranged on a scale from -3 to +3, with the following characteristics:

- **+3**
  - 33 find-solve-success
  - 18 work-skills-responsibilities
  - 21 work-skills-success
  - 31 find-solve-responsibilities
  - 12 manage-conflicts-success
  - 5 don’t-know-responsibilities
  - 9 manage-conflicts-responsibilities
  - 3 how-learn-watching
  - 8 don’t-know-reflection

- **+2**
  - 14 want-career-responsibilities
  - 19 work-skills-practice
  - 17 want-career-reflection
  - 15 want-career-practice
  - 26 communicate-well-responsibilities
  - 35 team-skills-responsibilities
  - 1 how-learn-responsibilities
  - 2 don’t-know-reflection

- **+1**
  - 38 expect-engineer-responsibilities
  - 36 team-skills-success
  - 32 find-solve-watching
  - 25 tech-skills-success
  - 22 tech-skills-responsibilities
  - 20 work-skills-watching
  - 16 want-career-watching
  - 6 don’t-know-practice
  - 2 how-learn-practice

- **0**
  - 41 expect-engineer-success
  - 29 communicate-well-success
  - 28 communicate-well-watching
  - 13 manage-conflicts-reflection
  - 10 manage-conflicts-practice
  - 4 how-learn-reflection
  - 7 don’t-know-watching
  - 27 communicate-well-practice
  - 2 how-learn-reflection

- **-1**
  - 41 expect-engineer-success
  - 29 communicate-well-success
  - 28 communicate-well-watching
  - 13 manage-conflicts-reflection
  - 10 manage-conflicts-practice
  - 4 how-learn-reflection
  - 7 don’t-know-watching
  - 27 communicate-well-practice
  - 2 how-learn-reflection

- **-2**
  - 11 manage-conflicts-watching
  - 24 tech-skills-watching
  - 34 find-solve-reflection
  - 39 expect-engineer-practice
  - 30 communicate-well-reflection
  - 37 team-skills-reflection
  - 40 expect-engineer-watching
  - 42 expect-engineer-reflection
12 – Aspen
Factor 1: Problem Solvers

-3
34 find-solve-reflection
37 team-skills-reflection

-2
4 how-learn-reflection
12 manage-conflicts-success

-1
14 want-career-responsibilities
16 want-career-watching

+2
38 expect-engineer-responsibilities
17 want-career-reflection

+1
23 tech-skills-practice
11 manage-conflicts-watching

0
24 tech-skills-watching
8 don't-know-reflection

+3
33 find-solve-success
22 tech-skills-responsibilities
2 how-learn-practice
27 communicate-well-practice
10 manage-conflicts-practice
6 don't-know-practice
1 how-learn-responsibilities
28 communicate-well-watching

+2
35 team-skills-responsibilities
19 work-skills-practice

+1
23 tech-skills-practice
8 don't-know-reflection

0
24 tech-skills-watching
8 don't-know-reflection

-1
11 manage-conflicts-watching
9 manage-conflicts-responsibilities

-2
42 expect-engineer-reflection
40 expect-engineer-watching

-3
34 find-solve-reflection
37 team-skills-reflection
13 – Ash
Factor 1: Problem Solvers
### Factor 1: Problem Solvers

<table>
<thead>
<tr>
<th>Score</th>
<th>Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+3</td>
<td>31 find-solve-responsibilities</td>
</tr>
<tr>
<td></td>
<td>33 find-solve-success</td>
</tr>
<tr>
<td></td>
<td>38 expect-engineer-responsibilities</td>
</tr>
<tr>
<td>+2</td>
<td>18 work-skills-success</td>
</tr>
<tr>
<td></td>
<td>14 want-career-responsibilities</td>
</tr>
<tr>
<td></td>
<td>19 work-skills-practice</td>
</tr>
<tr>
<td></td>
<td>25 tech-skills-success</td>
</tr>
<tr>
<td>+1</td>
<td>9 manage-conflicts-responsibilities</td>
</tr>
<tr>
<td></td>
<td>4 how-learn-reflection</td>
</tr>
<tr>
<td></td>
<td>3 how-learn-watching</td>
</tr>
<tr>
<td></td>
<td>2 how-learn-practice</td>
</tr>
<tr>
<td></td>
<td>1 how-learn-responsibilities</td>
</tr>
<tr>
<td></td>
<td>26 communicate-well-responsibilities</td>
</tr>
<tr>
<td></td>
<td>10 manage-conflicts-practice</td>
</tr>
<tr>
<td></td>
<td>12 manage-conflicts-success</td>
</tr>
<tr>
<td>0</td>
<td>42 expect-engineer-reflection</td>
</tr>
<tr>
<td></td>
<td>15 want-career-practice</td>
</tr>
<tr>
<td></td>
<td>23 tech-skills-practice</td>
</tr>
<tr>
<td></td>
<td>16 want-career-watching</td>
</tr>
<tr>
<td></td>
<td>39 expect-engineer-practice</td>
</tr>
<tr>
<td></td>
<td>11 manage-conflicts-watching</td>
</tr>
<tr>
<td></td>
<td>22 tech-skills-responsibilities</td>
</tr>
<tr>
<td></td>
<td>21 work-skills-success</td>
</tr>
<tr>
<td></td>
<td>27 communicate-well-practice</td>
</tr>
<tr>
<td></td>
<td>40 expect-engineer-watching</td>
</tr>
<tr>
<td></td>
<td>28 communicate-well-watching</td>
</tr>
<tr>
<td></td>
<td>17 want-career-reflection</td>
</tr>
<tr>
<td></td>
<td>20 work-skills-watching</td>
</tr>
<tr>
<td></td>
<td>37 team-skills-watching</td>
</tr>
<tr>
<td></td>
<td>8 don't-know-reflection</td>
</tr>
<tr>
<td></td>
<td>7 don't-know-watching</td>
</tr>
<tr>
<td></td>
<td>6 don't-know-practice</td>
</tr>
<tr>
<td>-2</td>
<td>30 communicate-well-reflection</td>
</tr>
<tr>
<td></td>
<td>29 communicate-well-success</td>
</tr>
<tr>
<td></td>
<td>34 find-solve-reflection</td>
</tr>
<tr>
<td></td>
<td>36 team-skills-success</td>
</tr>
<tr>
<td>-1</td>
<td>13 manage-conflicts-reflection</td>
</tr>
<tr>
<td></td>
<td>17 manage-conflicts-watch</td>
</tr>
<tr>
<td></td>
<td>24 tech-skills-watch</td>
</tr>
<tr>
<td></td>
<td>32 find-solve-watch</td>
</tr>
<tr>
<td></td>
<td>22 - Chris</td>
</tr>
</tbody>
</table>
Factor 2: Team Players

4 - Winter

-3
13 manage-conflicts-reflection
36 team-skills-success

-2
5 don’t-know-responsibilities

-1
8 don’t-know-reflection
16 want-career-watching
27 communicate-well-practice
39 expect-engineer-practice
21 work-skills-success
22 tech-skills-responsibilities
26 communicate-well-responsibilities
30 communicate-well-reflection

0
6 don’t-know-practice
4 how-learn-reflection
12 manage-conflicts-success
16 want-career-watching
19 work-skills-practice
23 tech-skills-practice
29 communicate-well-success
34 find-solve-reflection

+1
38 expect-engineer-responsibilities
41 expect-engineer-success
35 team-skills-responsibilities
40 expect-engineer-watching
3 how-learn-watching
24 tech-skills-watching
28 communicate-well-watching
10 manage-conflicts-practice

+2
1 how-learn-responsibilities
11 manage-conflicts-watching
17 want-career-reflection
40 expect-engineer-watching
7 don’t-know-watching

+3
14 want-career-responsibilities
18 work-skills-responsibilities
31 find-solve-responsibilities
20 work-skills-watching
25 tech-skills-success

-3
13 manage-conflicts-reflection
36 team-skills-success

-2
5 don’t-know-responsibilities

-1
8 don’t-know-reflection
16 want-career-watching
27 communicate-well-practice
39 expect-engineer-practice
21 work-skills-success
22 tech-skills-responsibilities
26 communicate-well-responsibilities
30 communicate-well-reflection

0
6 don’t-know-practice
4 how-learn-reflection
12 manage-conflicts-success
16 want-career-watching
19 work-skills-practice
23 tech-skills-practice
29 communicate-well-success
34 find-solve-reflection

+1
38 expect-engineer-responsibilities
41 expect-engineer-success
35 team-skills-responsibilities
40 expect-engineer-watching
3 how-learn-watching
24 tech-skills-watching
28 communicate-well-watching
10 manage-conflicts-practice

+2
1 how-learn-responsibilities
11 manage-conflicts-watching
17 want-career-reflection
40 expect-engineer-watching
7 don’t-know-watching
Factor 2: Team Players
26 – Kaden
Factor 2: Team Players
27 - Shawn
Factor 2: Team Players
2 – Jules
Factor 3: The Doers

0

-1

0

-2

-3

+3

+2

+1

-1

24 tech-skills-watching
22 tech-skills-success
23 tech-skills-practice
25 tech-skills-success
32 find-solve-reflection
3 how-learn-watching
8 don’t-know-reflection
7 don’t-know-watching

21 work-skills-success
30 communicate-well-reflection
17 want-career-reflection
37 team-skills-reflection
11 manage-conflicts-watching
5 don’t-know-responsibilities
40 expect-engineer-watching
41 expect-engineer-success
33 find-solve-success
35 team-skills-responsibilities
27 communicate-well-practice
29 communicate-well-success
12 manage-conflicts-success
9 manage-conflicts-responsibilities
1 how-learn-responsibilities
20 work-skills-watching
10 manage-conflicts-practice
36 team-skills-success
38 expect-engineer-responsibilities
34 find-solve-reflection
6 don’t-know-practice
16 want-career-watching
19 work-skills-practice
14 want-career-responsibilities
39 expect-engineer-practice
18 work-skills-responsibilities
2 how-learn-practice

6 - Corey
Factor 3: The Doers
<table>
<thead>
<tr>
<th>Factor 4</th>
<th>The Deciders</th>
</tr>
</thead>
<tbody>
<tr>
<td>+3</td>
<td>+2</td>
</tr>
<tr>
<td>+1</td>
<td>0</td>
</tr>
<tr>
<td>-1</td>
<td>-2</td>
</tr>
<tr>
<td>-3</td>
<td></td>
</tr>
</tbody>
</table>

- **+3**
  - 17 want-career-reflection
  - 16 want-career-watching
  - 5 don't-know-responsibilities
  - 3 how-learn-watching

- **+2**
  - 39 expect-engineer-practice
  - 38 expect-engineer-responsibilities
  - 25 tech-skills-success
  - 23 tech-skills-practice

- **+1**
  - 40 expect-engineer-watching
  - 31 find-solve-responsibilities
  - 30 communicate-well-success
  - 29 communicate-well-watching

- **0**
  - 41 expect-engineer-success
  - 38 find-solve-success
  - 32 find-solve-watching
  - 29 communicate-well-success
  - 26 communicate-well-responsibilities
  - 24 tech-skills-watching
  - 22 tech-skills-responsibilities
  - 21 work-skills-success
  - 20 work-skills-watching
  - 19 work-skills-practice
  - 18 work-skills-responsibilities
  - 17 manage-conflicts-success
  - 16 manage-conflicts-watching
  - 15 want-career-practice
  - 14 want-career-responsibilities
  - 12 manage-conflicts-success
  - 11 manage-conflicts-watching
  - 10 manage-conflicts-practice
  - 9 manage-conflicts-responsibilities
  - 7 don't-know-watching
  - 6 don't-know-practice
  - 5 don't-know-responsibilities
  - 3 how-learn-watching
  - 2 how-learn-practice
  - 1 how-learn-responsibilities
  - 1 how-learn-reflection
  - 4 how-learn-reflection

- **-2**
  - 35 team-skills-responsibilities
  - 34 find-solve-watching
  - 33 team-skills-watching
  - 32 team-skills-success
  - 31 team-skills-reflection
  - 21 work-skills-success
  - 20 work-skills-watching
  - 19 work-skills-practice
  - 18 work-skills-responsibilities
  - 17 manage-conflicts-success
  - 16 manage-conflicts-watching
  - 15 want-career-practice
  - 14 want-career-responsibilities
  - 12 manage-conflicts-success
  - 11 manage-conflicts-watching
  - 10 manage-conflicts-practice
  - 9 manage-conflicts-responsibilities
  - 7 don't-know-watching
  - 6 don't-know-practice
  - 5 don't-know-responsibilities
  - 3 how-learn-watching
  - 2 how-learn-practice
  - 1 how-learn-responsibilities
  - 1 how-learn-reflection
  - 4 how-learn-reflection

- **-3**
  - 30 communicate-well-reflection
  - 28 communicate-well-watching
  - 27 communicate-well-practice
  - 26 communicate-well-responsibilities
  - 25 tech-skills-watching
  - 24 tech-skills-responsibilities
  - 23 tech-skills-practice
  - 22 tech-skills-success
  - 21 work-skills-success
  - 20 work-skills-watching
  - 19 work-skills-practice
  - 18 work-skills-responsibilities
  - 17 manage-conflicts-success
  - 16 manage-conflicts-watching
  - 15 want-career-practice
  - 14 want-career-responsibilities
  - 12 manage-conflicts-success
  - 11 manage-conflicts-watching
  - 10 manage-conflicts-practice
  - 9 manage-conflicts-responsibilities
  - 7 don't-know-watching
  - 6 don't-know-practice
  - 5 don't-know-responsibilities
  - 3 how-learn-watching
  - 2 how-learn-practice
  - 1 how-learn-responsibilities
  - 1 how-learn-reflection
  - 4 how-learn-reflection
Factor 4: The Deciders

8 – Dale
Factor 4: The Deciders

17 – Julian

+3
-3
+2
-2
+1
-1

3 how-learn-reflection
5 don't-know-responsibilities
17 want-career-reflection
23 tech-skills-practice
25 tech-skills-success
22 tech-skills-responsibilities
10 manage-conflicts-practice
18 work-skills-responsibilities
42 expect-engineer-reflection
37 team-skills-reflection
30 communicate-well-reflection
34 find-solve-reflection
35 team-skills-responsibilities
20 work-skills-practice
13 manage-conflicts-reflection
28 communicate-well-watching
8 don't-know-reflection
20 work-skills-watching
27 communicate-well-practice
26 communicate-well-responsibilities
29 communicate-well-success
31 find-solve-responsibilities
41 expect-engineer-success
33 find-solve-success
38 expect-engineer-responsibilities
19 work-skills-practice
15 want-career-practice
16 want-career-watching
19 work-skills-watching
11 manage-conflicts-watching
32 find-solve-watching
36 team-skills-success
6 don't-know-practice
7 don't-know-watching
24 tech-skills-watching
2 how-learn-practice
40 expect-engineer-watching
17 - Julian

Factor 4: The Deciders

+3
-3
+2
-2
+1
-1

3 how-learn-reflection
5 don't-know-responsibilities
17 want-career-reflection
23 tech-skills-practice
25 tech-skills-success
22 tech-skills-responsibilities
10 manage-conflicts-practice
18 work-skills-responsibilities
42 expect-engineer-reflection
37 team-skills-reflection
30 communicate-well-reflection
34 find-solve-reflection
35 team-skills-responsibilities
20 work-skills-practice
13 manage-conflicts-reflection
28 communicate-well-watching
8 don't-know-reflection
20 work-skills-watching
27 communicate-well-practice
26 communicate-well-responsibilities
29 communicate-well-success
31 find-solve-responsibilities
41 expect-engineer-success
33 find-solve-success
38 expect-engineer-responsibilities
19 work-skills-practice
15 want-career-practice
16 want-career-watching
19 work-skills-watching
11 manage-conflicts-watching
32 find-solve-watching
36 team-skills-success
6 don't-know-practice
7 don't-know-watching
24 tech-skills-watching
2 how-learn-practice
40 expect-engineer-watching
<table>
<thead>
<tr>
<th>+3</th>
<th>+2</th>
<th>+1</th>
<th>0</th>
<th>-1</th>
<th>-2</th>
<th>-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 expect-engineer-watching</td>
<td>3 how-learn-watching</td>
<td>27 communicate-well-practice</td>
<td>38 expect-engineer-responsibilities</td>
<td>38 expect-engineer-practice</td>
<td>-2</td>
<td>17 want-career-reflection</td>
</tr>
<tr>
<td>1 how-learn-responsibilities</td>
<td>26 communicate-well-responsibilities</td>
<td>12 manage-conflicts-success</td>
<td>23 tech-skills-practice</td>
<td>23 tech-skills-reflection</td>
<td>-3</td>
<td>15 want-career-practice</td>
</tr>
<tr>
<td>5 don't-know-responsibilities</td>
<td>25 team-skills-responsibilities</td>
<td>19 work-skills-practice</td>
<td>28 communicate-well-watching</td>
<td>28 communicate-well-success</td>
<td>-2</td>
<td>16 want-career-watching</td>
</tr>
<tr>
<td>7 don't-know-watching</td>
<td>32 find-solve-watching</td>
<td>6 don't-know-practice</td>
<td>29 communicate-well-reflection</td>
<td>29 communicate-well-watching</td>
<td>-2</td>
<td>17 want-career-reflection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
23 - Ryan
NO FACTOR
REFERENCES


Coursework?,” in American Society for Engineering Education Annual Conference & Exposition, 2011.


