

Attitude Toward Context and Self-efficacy in and Willingness for Adaptability
of Engineering Faculty in Two Divergent Curricular Change Contexts:

A Quantitative and Qualitative Analysis

by

Hadi Ali

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved October 2021 by the
Graduate Supervisory Committee:

Ann McKenna, Chair
Jennifer Bekki
Rod Roscoe

ARIZONA STATE UNIVERSITY

December 2021

ABSTRACT

Although knowledge about effective teaching and learning exists, and theories of change strategies are considered, the lack of the understanding of the behavior of engineering faculty during curricular change remains a major contributor against robust efforts for change. In this work, faculty adaptability is conceptualized as self-regulation during curricular change. Faculty participants were recruited from two divergent curricular change contexts: one that is prescribed with interdependence while the other is emergent with uncertainty. In this study, attitude toward context's strength is conceptualized along the four dimensions of clarity, consistency, constraints, and consequences of the context, while faculty's self-efficacy and willingness for adaptability are conceptualized along the three dimensions of planning, reflecting, and adjusting. This study uses a mixed method, quantitative-qualitative, sequential explanatory research design. The quantitative phase addresses the question of "How does faculty group in the first context differ from faculty group in the second context in terms of self-efficacy and willingness for planning, adjusting, and reflecting?" The qualitative phase addresses the question of "How do faculty respond to curricular change, as exhibited in their activities of planning, adjusting, and reflecting during change?" Findings point to differences in patterns of correlations between attitude toward context with both self-efficacy and willingness across the two contexts, even though analysis showed no significant differences between attitude toward context, self-efficacy, and willingness across the two contexts. Moreover, faculty participants' willingness for adjusting, in both contexts, was not correlated with neither attitude toward context's clarity nor constraints. Furthermore, in the prescribed

context, Group A faculty (self-identified as Lecturers, Senior Lecturers, or Adjunct Faculty) showed higher willingness for planning, adjusting, and reflecting activities, compared to Group B faculty (self-identified as Assistant, Associate or Full Professors). Also, in the prescribed context, Group A faculty showed no overall significant correlation with attitude toward context. This study has implications on the way change is conceived of, designed, and implemented, when special attention is given to faculty as key change agents. Without the comprehensive understanding of the adaptability of faculty as key change agents in the educational system, the effective enacting of curricular change initiatives will remain unfulfilled.

To Mom and Dad

ACKNOWLEDGMENTS

I have found this part of the dissertation to be the hardest to write. In the dissertations I have read (and I have read a few), I have found this part to be the most enjoyable and insightful to read. I could talk about Dr. McKenna's genuine character, hard work ethics, and integrity, and I will not do justice. I first met Dr. McKenna in an interview for a position I had applied for at the Poly campus. The meeting was short, and I was offered the position. But I decided to go home for a while to transfer my experience in engineering education to Jordan. I found the Poly campus to be unique from the first sight; Dr. McKenna was the Director at the time. I felt that one day I was going to be back to this campus to pursue my doctoral studies in Engineering Education Systems and Design—a program that was still in the making when I first visited for my interview. I found a unique niche in this program, being one that is focused on “Systems and Design” of the educational enterprise—an area that appeals to me. In my prior graduate studies at Purdue, I met with Norm Augustine, a well-known figure in aerospace as well as in shaping the innovation policy of science and technology in the US. When I explained my interests and background to him, he immediately encouraged me to study education as a system. There was no other place for me to pursue my ideas other than ASU, and no other PhD advisor who could harness my diverse interests other than Dr. McKenna.

Dr. Bekki was the Chair of search committee when I applied for the position at the Poly campus. She drove me the first time from the hotel in Tempe to the campus. Her genuine interest in knowing me at the personal level had always made me comfortable

working with her. Dr. Roscoe was always available to exchange ideas and opened my thinking to testing new ideas. I first interacted with him informally in the office space over a water cooler discussion. During the pandemic, I asked him to join my committee—all our interactions since then were virtual, until I met him again in-person during my defense. I am grateful for everything I have experienced during my time at ASU. But most importantly, I am grateful for watching closely the leadership of Dr. McKenna during the pandemic, of The Polytechnic School and as the Vice Dean of Engineering. I would like to think that I am a keen observer, and this has been the most impactful experience on me.

During my doctoral studies, I took Dr. Michael Crow's class on *Science, Technology and Public Affairs*. I have come to know Dr. Crow's genuine character and his humble beginnings. Everyone I met said that I couldn't be around Mike without being transformed—this is true! I found that Dr. Crow and I share one thing in common—that we both can't understand the idea of a “major” in education, which might explain my background. All these experiences have transformed me, personally and professionally. Now, it's time to give back.

I'm thankful for the great times with my friends and colleagues at EESD, The Polytechnic School, the Graduate and Professional Students Association, Changemaker Central, the Decision Theater, the Karate Dojos, and the Islamic Community Center at Tempe. I'm also thankful for my friends and colleagues at Purdue's Hawkins Hall, the Purdue Memorial Union, the First-Year Engineering Experience and Dr. Eric Holloway, and the Minority Engineering Program at Purdue and Dr. Cinthia Sanchez. My special thanks to my colleagues at the University of Jordan and Dr. Lutfi Al-Sharif for his encouragement.

Mom, Dad, Manar, Nida, Jumana and Mohammad: Words are not enough.

TABLE OF CONTENTS

	Page
LIST OF TABLES.....	ix
LIST OF FIGURES.....	xii
CHAPTER	
1 INTRODUCTION.....	1
Calls for Change in Engineering Education: Enabling Change Agents.....	1
The Role of Individual Stakeholders in Curricular Change Efforts.....	4
Faculty Roles and Contribution to Curricular Change.....	7
Purpose of This Study and Map of the Dissertation.....	10
2 LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK.....	12
Characterizing the Relationship Between Change at the Course-level and Change at the Curriculum-level.....	12
Decision Points in the Curriculum as an “Academic Plan”.....	16
Connections Between Defining the Curriculum as an “Academic Plan” and Other Definitions.....	19
Conceptualizing Adaptability as Self-regulation.....	25
Planning.....	29
Adjusting.....	36
Reflecting.....	43
Conceptualizing Contexts.....	50
List of Hypotheses.....	55

CHAPTER	Page
3	METHODS..... 59
	Mixed Methods Research Design: Alignment with the Purpose of Study 59
	Quantitative Research Method 61
	Qualitative Research Method..... 88
	Limitations and Subjectivity Statement 105
4	QUANTITATIVE ANALYSIS RESULTS 108
	Role-type Differences 112
	Years of Teaching Differences..... 120
	Gender Differences..... 122
	Summary of Major Results from Quantitative Phase..... 124
5	QUALITATIVE FINDINGS..... 126
	Differences in Willingness for Planning..... 127
	Differences in Self-efficacy in Planning 143
	Differences in Willingness for Adjusting 160
	Differences in Self-efficacy in Adjusting..... 176
	Differences in Willingness for Reflecting 190
	Differences in Self-efficacy in Reflecting..... 198
	Summary 209
6	DISCUSSION 210
	How Do the Qualitative Findings Explain the Quantitative Analysis Results? ..210
	Situating the Findings in the Literature 225

CHAPTER	Page
Study Contributions	232
Practical Implications for this Study and Future Work.....	236
7 CONCLUSION	241
REFERENCES	242
 APPENDIX	
A IRB APPROVAL FOR RESEARCH INVOLVING HUMAN SUBJECTS.....	266
B QUANTITATIVE RECRUITMENT EMAIL IN CONTEXT I.....	268
C QUANTITATIVE RECRUITMENT EMAIL IN CONTEXT II	270
D QUALITATIVE RECRUITMENT EMAIL IN CONTEXT I.....	272
E QUALITATIVE RECRUITMENT EMAIL IN CONTEXT II.....	274
F QUANTITATIVE SURVEY INSTRUMENT CONSENT FORM.....	276
G QUALITATIVE INTERVIEW CONSENT FORM.....	281
H INTERVIEW PROTOCOL.....	284
I QUALITATIVE ANALYSIS CODE BOOK.....	288

LIST OF TABLES

Table	Page
1. Suggested Actions for Individuals in the Educational System, Including Faculty, Offered As Recommendations for Change in Engineering Education. Suggested Actions Often Lack Clear Mechanism for Implementation. (“ASEE”, 2009).....	3
2. Attributes of Faculty Conceived in the Literature As Barriers to Change.	10
3. Mapping between Decision Points in the Curriculum As An Academic Plan and the Role of Faculty in Contexts I and II.....	18
4. Some Definitions of a Curriculum and the Embedded Role of Faculty in Each Definition	20
5. Curriculum Administration Functions As They Relate to the Responsibilities of Faculty. Adapted from Lattuca & Stark (2009, p. 272).....	40
6. Indicators Faculty Use in Professional Judgement of Student Learning. (Starks et al., 1990)	48
7. Operational Definitions for Facets of the Framework Characterizing Contexts (Meyer et al., 2010).....	51
8. Comparison Between the Dependent Variables across Context I and Context II.....	57
9. Comparison Between the Independent Variables across Context I and Context II (Based on Characterization of Each Context).....	57
10. Relationships Between the Independent Variables and Dependent Variables in Context I.	58

Table	Page
11. Relationships Between the Independent Variables and Dependent Variables in Context II.	58
12. List of Demographics Questions.	66
13. Final Items Used in Collecting Data about Self-efficacy in Planning (items 1-5), Self- efficacy in Adjusting (items 6-10) and Self-efficacy in Reflecting (items 11-15).....	71
14. Final Items Used in Collecting Data about Willingness for Planning (items 1-5), Willingness for Adjusting (items 6-10) and Willingness for Reflecting (items 11-15).	72
15. Final Items Used in Collecting Data about Attitude toward Context’s Clarity (items 1-5), Consistency (items 6-10), Constraints (items 11-15) and Consequences (items 16-20). ..	73
16. Faculty Participants Distribution across the Two Contexts, Based on Gender, Role-type, Years of Experience and Race/ethnicity.	76
17. First Round Analysis to Check for Suitability of Data for Factor Analysis, for Each Construct in Each Context.	78
18. Factor Loading for Final Items Retained for Analysis after the EFA for the Self-efficacy in Planning (items 1-5), Self-efficacy in Adjusting (items 6-10) and Self-efficacy in Reflecting (items 11-15) Constructs.	80
19. Factor Loading for Final Items Retained for Analysis after the EFA for the Willingness for Planning (items 1-5), Willingness for Adjusting (items 6-10) and Willingness for Reflecting (items 11-15) Constructs.	81
20. Factor Loading for Final Items Retained for Analysis after the EFA for the Attitude toward Context’s Clarity (items 1-10) and Constraints (items 11-15).	82

Table	Page
21. List of Participants of the Qualitative Study.....	95
22. Results of Inter-rater Reliability Analysis.....	105
23. Mean Scores, Standard Deviations, and Comparisons of Means across Contexts.....	108
24. Correlations among Self-efficacy and Willingness Measures and Attitude toward Context Measures.....	109
25. Means and Standard Deviations across Role-type within Each Context.....	114
26. Pearson Correlations for SE and W of Adaptability Phases and Attitude toward Context across Role-type within Each Context.....	117
27. Results of Multiple Regression Analyses for Both Group A and B Faculty in Both Contexts.....	119
28. Mean Differences, Categorized by Years of Teaching Experience, for Self-efficacy in and Willingness for Planning, Adjusting and Reflecting as well as Attitude toward Context Clarity and Constraints, for Each Context.....	121
29. Mean Differences, Categorized by Reported Gender, for Self-efficacy in and Willingness for Planning, Adjusting and Reflecting as well as Attitude toward Context Clarity and Constraints, for Each Context.....	123
30. How Do the Qualitative Findings Explain the Quantitative Analysis Results?	212

LIST OF FIGURES

Figure	Page
1. Based on the Work of Henderson et al. (2011), Change Theories Can Be Mapped into One of Four Categories of Change Strategies. Figure Adapted from Henderson et al. (2011).	5
2. Mapping the Elements of the Curriculum As an Academic Plan, As Proposed by Lattuca & Stark (2009), to the Different Phases of Adaptability in Order to Instantiate Items Relevant to Academic Contexts for this Study.	17
3. The Triadic Model of Self-regulation (Zimmerman, 1989).	26
4. The Cyclical Phase Model of Self-regulation (Zimmerman, 2000).	26
5. The Winne and Hadwin's Model of Self-regulation (1998).	27
6. Common Themes of Phases and Areas of Regulation in Models of Self-regulation, As Proposed by Pintrich (2000)	27
7. Conceptualization of Adaptability As Self-regulation in This Study.	28
8. Context I: Hypothetical Relationships between Attitude Toward Context (As Predictors) and Dimensions of Adaptability (Self-efficacy in Self-regulation).	56
9. Context II: Hypothetical Relationships between Attitude toward Context (As Predictors) and Dimensions of Adaptability (Self-efficacy in Self-regulation).	56
10. Directional Instructions Presented to Participants in the Beginning of the Instrument Survey in Context I.	70
11. Summary of Emerged Themes from the Qualitative Study.	211

Figure	Page
12. Reflecting, a Reported Under-utilized Step, Is Essential to Initiating A New Cycle of Adaptation.....	238

CHAPTER 1

INTRODUCTION

1. Calls for change in engineering education: Enabling change agents

1.1 Change in response to contextual demands

Calls for change in engineering education has constantly been shaped by “changing times and paradigms” (Felder, 2004, p. 32). The context within which engineering graduates are educated, and are expected to contribute to in the workplace, has always been a dominant factor in frameworks for calls for change (Jamieson & Lohmann, 2009). Characteristics of the context such as the influence of the global economy, the knowledge-based economy, changing demographics, increased integration among engineering disciplines and environmental factors are just some examples (Katehi et al., 2004). In many of the national reports that call for change in engineering education, the lack of preparation of engineering graduates to address the challenges of a changing world are cited (e.g., Duderstadt, 2008; National Academy of Engineering [NAE], 2004, 2005; National Research Council [NRC], 2007; National Science Board [NSB], 2007; Nielsen, 2011). The reports do not only cite the quality of outcome but also point to the lack of comprehensive understanding of the learning process (e.g., “NAE”, 2005) affecting both the design of the engineering curriculum and the delivery of the curriculum (Duderstadt, 2008).

1.2 The focus on the “what” not the “how”

In addition to characterizing the problem, national as well as international calls for change, tend to provide solutions in the form of recommendations. Proposed recommendations

include addressing pedagogy issues, such as student-centeredness and authentic learning experiences, which integrate into the curriculum the humanities, global competencies, and teamwork and communication skills (Borri & Maffioli, 2007; King, 2008; Nielsen, 2011). However, challenges exist in implementing these recommendations (Borrego, Froyd, & Hall, 2010; “NSF”, 2008). Recommendations characterize *what* engineering education should look like with little attention to *how* to implement change (“ASEE”, 2009). See, for example, a list of recommendations provided by the ASEE report on *Creating a culture for scholarly and systematic innovation in engineering education* (2009), Table 1. The suggested actions are listed for engineering faculty, chairs and deans. The recommendations are provided in broad terms without clear articulation of the realization process of these aspirations. Investments in understanding effective pedagogies have been made (Borrego et al., 2010; “NRC”, 2012; Prince & Felder, 2006). However, challenges continue to exist for faculty to adopt and scale research-based pedagogies and interventions (“ASEE”, 2009; 2012; “NRC”, 2012; “PCAST”, 2012). The same ASEE report (2009) includes the following quote about the hardest part of change:

““The hard part of being adaptive and innovative is that often it forces us to change ourselves, our environments, or both. These changes can evoke strong emotions and take us away from our momentary efficiencies and comfort zones by forcing us to unlearn old skills, [and] tolerate momentary chaos and ambiguity in order to move forward...” (Bransford, 2007, p. 2)”

Table 1. Suggested actions for individuals in the educational system, including faculty, offered as recommendations for change in engineering education. Suggested actions often lack clear mechanism for implementation. (“ASEE”, 2009)

Stakeholder	Suggested action
Engineering faculty, chairs, and deans	<ul style="list-style-type: none"> • Link engineering education practice and research • Support and recognize educational innovation • Prepare future faculty • Integrate the curriculum • Promote learning through entrepreneurship • Educate the global engineer • Develop leaders • Promote learning through service • Enhance faculty experience

1.3 The need to understand enablers and barriers for individuals to change

Two related factors that contribute to the challenge of implementing change are the *status-quo*, represented by organizational structures and systems that make up the educational process (Borrego et al., 2010; “NSB”, 2007) and *change agents*, represented by faculty and administration leaders who are willing to embrace change efforts while viewing them as scholarly-sound and as based on research (Borrego & Henderson, 2014). In the past, the problem of *enabling* faculty and administration leaders to emerge as change agents to change the status quo has been characterized as a “shift” in emphasis from teaching to learning (Seymour, 2002) and as “maintaining balance” between theory and practice (Reynolds & Seely, 1993; Seely, 1999). However, efforts to guide faculty and administration leaders in the change process remain implicit (Borrego & Henderson, 2014).

2. The role of individual stakeholders in curricular change efforts

2.1 Models for change

In order to effectively implement proposals for curricular change, a careful understanding of the relationship between stakeholders and the curriculum is necessary. Henderson et al. (2010, 2011) developed a categorization of strategies used to create change in STEM education, Figure 1. Based on their categorization, which is developed after reviewing 191 journal articles published between 1995 and 2008 on the topic, change strategies can be mapped into one of four categories. The categories can be organized along two criteria. The first criteria, represented by the vertical axis in Figure 1, focuses on the aspect of the system to be changed. Pedagogical change made by *individual* faculty (upper left of this dimension) can be the most obvious form of change. Notably, changing the *environment and structure* of the educational system (lower left of this dimension) involves interaction between the curriculum and faculty. The second criteria, represented by the horizontal axis in Figure 1, focuses on the intended outcome. Reflective changes made by individual faculty (upper right corner) can result in *emergent* changes; similarly, developing a shared vision (lower right corner) can result in *emergent* changes; similarly, developing a shared vision (lower right corner). Alternatively, using a prescribed set of textbook and materials can result in a *prescribed* intended outcome (lower end of this dimension).

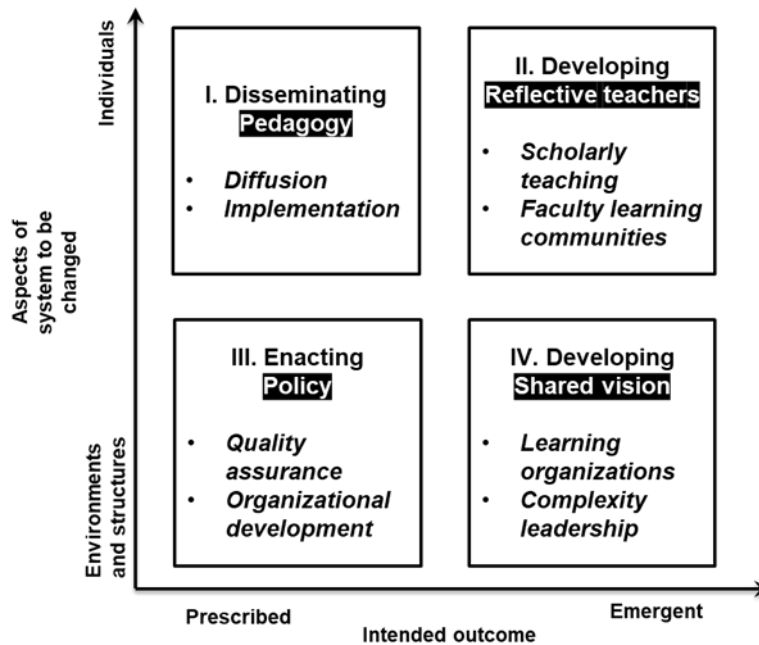


Figure 1. Based on the work of Henderson et al. (2011), change theories can be mapped into one of four categories of change strategies. Figure adapted from Henderson et al. (2011).

The categorization by Henderson et al. (2010, 2011) is consistent with other efforts to categorize theories of change (e.g., Amundsen & Wilson, 2012) and has been utilized by Borrego & Henderson (2014) to identify ways to increase the use of evidence-based teaching in engineering education. Most importantly, the framework highlights the efforts of faculty as agents for change in all four categories. However, while the several theories are provided as suggestions for change patterns in engineering education, the link between faculty (as active agents for change) and the curriculum (as an embodiment of many of the assumptions of the educational system) remain implicit. In the following discussion, an analysis of the relationship between stakeholders and contexts in models of curricular change is provided.

2.2 The link between the individual and the curriculum in models of change

Consider the first category in Figure 1, *disseminating pedagogy*. This category represents change strategies that focus on faculty members as individuals. Such strategies include highly structured interventions (Seymour, 2002) provided to faculty members to implement and assuming they have limited time to reflect on their teaching (Borrego & Henderson, 2014).

This change strategy uses the diffusion framework developed by Rogers (2003):

Awareness—Interest—Evaluation—Trial—Adoption. While it is necessary to develop awareness within individual faculty about skills beyond their experiences, the strategies may not be implemented in the curriculum appropriately or conform with traditional curricula (Besterfield-Sacre, et al., 2014).

The second category *developing reflective teachers* is based on the literature of reflective practice (e.g., Schon, 1983, 1987; Zeichner & Liston, 1987). This category of change strategies has the characteristic of being emergent. Although faculty may develop ownership of the emerged practice in the curriculum, a faculty may face the dilemma of not being rewarded using this approach, especially when such practices are not always grounded on educational research. At the same time, practicing reflection, as a member of a faculty community, may be effective in impacting and supporting a group of faculty (Borrego & Henderson, 2014).

The third and fourth categories in Figure 1 represent change strategies which are intended toward changing the environment or the structure of the educational system. Faculty may engage in these efforts at different levels. In the third category, for example, they may adopt or subvert proposed policy changes. While steps for developing a new policy

may engage faculty if quality evaluation and assurance processes are followed (Ewell, 1997; Rhoades & Sporn, 2002), the actual implementation may be complicated as the coupling between the administration and the faculty community is not always clear (Besterfield-Sacre et al., 2014). Furthermore, the development of a shared vision among faculty (fourth category) with regard to the environment or structure of the educational system is both a resource-intensive endeavor (Nonaka & Takeuchi, 1995) and may lack a clear guidance for realizing (Dill, 1999; Senge, 2000).

3. Faculty roles and contribution to curricular change

3.1 The complexity of developing an “ideal curriculum”

The engineering curriculum went through different waves of transformation (see, for example, Seely, 1999, 2005; Seymour, 2002; Wankat, 2004). A common theme has been bridging the gap between the preparation of graduating engineers and the needs of the workplace (Seely, 2005). The question of the fit between engineering faculty, with their focus on engineering science, and their ability to translate the theoretical applications in ways that are effective for preparing engineers has always been of concern (Walker, 1989). In the past, in most engineering curricula, students did not interact with engineering faculty until late in their sophomore year. Initial efforts to focus on design courses in the first year in the curriculum was an attempt to allow students to interact with engineering faculty early in the curriculum (Agogino, Sheppard, & Oladipupo, 1992; Pavelich, Olds, & Miller, 1995). At the same time, challenges started to emerge to effectively integrate design into the engineering curriculum (e.g., Crawley, 2002) and to identify effective ways for assessment (Dym et al.,

2005). Some faculty were comfortable engaging in a pedagogy based on project-based learning (PBL) (Smith et al., 2005), and employers started to recognize the qualities that PBL provides for students, including communication, teamwork skills and interest in life-long learning (Oakes, Coyle, & Jamieson, 2000; Smith, 2004).

The constantly changing nature of the engineering curriculum, in concert with economic, social and global contexts, continuously call for engineering faculty to adapt, by incorporating new content and utilizing effective educational interventions. A recent study on *The Global State of the Art in Engineering Education* identified features that distinguish current leaders and emerging leaders in engineering education by comparing their different curricular approaches (Graham, 2018). Some of the identified curricular features included design and make-based learning, collaborative cultures, academic rigor in the engineering fundamentals, multidisciplinary, work-ready environments and self-directed learning (Graham, 2018). Additionally, pedagogical features associated with current leaders included “technology-based extra-curricular activities” and “emerging capabilities in online and blended learning” (p. 30). The expansive and evolving nature of the engineering curriculum, in terms of both content and form, points to the changing nature of the role of faculty.

3.2 The role of faculty in curricular change

As illustrated in the previous discussion, many of the change calls are initiated as external factors making influence on the engineering curriculum. However, the actual realization of these calls falls upon the engineering faculty as change agents. Without the contribution of faculty, the implantation of change is not robust (Besterfield-Sacre et al., 2014). Faculty are

being asked to engage in structured change efforts (Henderson, Finkelstein, & Beach, 2010), to work together in interdisciplinary groups (Henderson et al., 2008) and to become partners in the change process (Henderson & Dancy, 2008; Henderson et al., 2010). However, while there is a recognition of the fundamental role that faculty play, no sufficient attention has been given to their adaptability in response to change.

Individual characteristics have been identified as a constraint on faculty's willingness to engage in change (Murray & Macdonald, 1997; Norton et al., 2005; Prosser & Trigwell, 1999). Furthermore, the reward system and the already existing expectations in the engineering disciplines have been brought into attention as barriers to change (Besterfield-Sacre et al., 2014). Faculty have an individual agency to make decisions that is not usually attuned to in change proposals (Kezar & Eckel, 2002; Wejnert, 2002). Different change proposals assume immediate adoption from faculty, when in reality the lack of willingness to adapt, or only superficial adoption results in ineffective change (Henderson, 2005; Henderson & Dancy, 2005; Seymour, DeWelde, & Fry, 2011). Table 2 lists aspects of the role of faculty that are not considered early in calls for change and end up being considered as barriers for change.

Table 2. Attributes of faculty conceived in the literature as barriers to change.

Faculty attributes that are cited as barriers to change
<ul style="list-style-type: none">• Expectations of content coverage• Limited instructor time• Lack of training• Departmental norms• Dealing with student resistance• Dealing with class size and room layout• Time structure• Institutional reward system• Institutional culture• Research priorities

4. Purpose of this study and map of the dissertation

Although knowledge about effective teaching and learning exists, and theories of change strategies are considered, the lack of the understanding of the behavior of change agents, as a unit of analysis, during the process of change, remains a major contributor against more robust change efforts. Without the comprehensive understanding of the adaptability of key change agents in the educational system, and as they respond to dynamic and changing contexts, the effective enacting of curricular change initiatives remains unfulfilled.

Overall, while change strategies consider various stakeholders, the central role that faculty play during the process remains generic and perspective without emphasis on *how* faculty actually respond to calls for change. The ability of the individual faculty to respond to change has not been thoroughly addressed in the literature. Calls for change assume immediate adoption from faculty, overlooking their independent decision agency and their willingness to partner in enacting and evaluating change efforts. Without the understanding of the individual response behavior of faculty during change, change proposals will continue to be incomplete and have insufficient impact.

The overarching purpose of this study is to enhance our understanding of the relationship between faculty *attitude toward the context* of curricular change and *self-efficacy in* and *willingness for* adaptability in that context. In the broader view of this research, adaptability is compared in two contexts: one that is motivated by the “proactive” desire for improvement of the curriculum; and another that is motivated by the “reactive” response to change in the environment. The first context (Context I)—integrating the entrepreneurial mindset in the engineering curriculum—is characterized as being highly interdependent, requiring combining efforts in a collaborative behavior, as opposed to individualized faculty tasks and roles. The second context (Context II)—curricular change in response to the COVID-19 pandemic—is characterized as one that is highly uncertain, requiring emergent work roles from faculty, as opposed to formalized work roles.

Chapter 2 characterizes the problem by mapping the space of what we know about curricular change and adaptability of individuals. It also characterizes the problem in terms of useful theories and concepts that shaped the design of this study. Chapter 3 describes the research design used in this study, with the rationales for decisions made and an assessment of quality considerations. The matching between the phenomenon under study and the research design is detailed, along with collected data and analysis methods. In Chapter 4 the results from the quantitative analysis are shared, and in Chapter 5 the qualitative findings are shared. In Chapter 6, the results are discussed with an effort to explain their meaning, situate them in the literature landscape, and highlight their implications. Finally, in Chapter 7, the conclusions are provided as they respond to the posed research questions.

CHAPTER 2

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

1. Characterizing the relationship between change at the course-level and change at the curriculum-level

1.1 Forms of change

A course can be defined as “a unit of instruction in which a group of students are taught by one or more teachers” (Stark, 2000, p. 436). In higher education in the United States, courses represent the building blocks of the curriculum (Dressel, 1965) where a course is scheduled typically to meet one to four hours a week over a “quarter” (often ten weeks) to a ‘semester’ (usually 14 to 15 weeks)” (Stark, 2000, p. 436). In the undergraduate curriculum, full-time students enroll in three to five courses each quarter or semester (Stark, 2000). Historically, the notion of a credit hour has been emphasized in the US since the early 20th century (Huthcnenson, 1997; Levine, 1978). The links between the different courses is referred to as the *structure* of the curriculum (Lattuca & Stark, 2009). According to Bergquist et al. (1981), most of efforts of curricular change tend to focus modifying the structure of the curriculum, which includes adjusting course offerings, recombining topics from sets of courses or changing required credit hours for graduation. In engineering education, for example, the Mann’s report (1918) discussed the suitable number of credit hours in the engineering curriculum and the variation of topics. Similarly, *The Engineering of 2020* report discussed the restructuring of the curriculum (“NAE”, 2004). A more structured analysis, however, of forms of curricular change is offered by Toombs & Tierney (1991) who observed three forms of curricular change: *modification*, *integration* and *transformation*.

In the sections below, these three forms of change are discussed with emphasis on characterizing the course-curriculum change relationship. Illustrative examples from change in engineering curriculum are provided for each form. There are different models and strategies for curricular change; the focus in the discussion below is on the mentioned three different forms of change because they are common in all models and strategies, and because of their relevance here to the discussion on the course-curriculum relationship.

1.2 “Modification” as a form of course-curricular change

In the *modification* form of curricular change, change happens primarily at the course-level where new knowledge are being accounted for by adapting to new theory or professional practice. This form of change emphasizes positivism and reductionism in the specialization of professions (Clark, 1983). New knowledge in this form is compartmentalized (Hopmann, 1991) within specific boundaries; these specific boundaries will end up defining academic disciplines and the relationships between them. In engineering education, *modification* as a form of curriculum change is the most common as new advances in technologies and changes in the practice always call for the incorporation of new theory and professional practice. Consider, for example, the increased emphasis on the human element in design and engineering, starting to emerge in the Grinter report (1955), or, *The Engineer of 2020* report, which in 2004, was calling for engineering curricula to address in courses the outlook of then future year of 2020 with regards to both the positive and negative byproducts of technology (“NAE”, 2004). In this form of change, making modifications at the course-level is assumed to represent change at the curriculum-level.

1.3 “Integration” as a form of course-curricular change

The *integration* form of curricular change counteracts the reductionist approach of the previous form. As a form of change, *integration* calls for unity, synthesis and the avoidance of fragmented structures of knowledge (Clark & Wawrytko 1990). The integrated curriculum received special attention in the 1980s and the 1990s (Boyer 1987). However, Toombs & Tierney (1991) noted that proposals for integrated learning tend to focus only on “a segment of the total curriculum, one constellation of courses” (p. 8). In engineering education, the 1990s, for example, witnessed the rise of calls to integrate engineering design with the engineering sciences (Dym et al., 2005). Other recent examples are the integration of sustainability into the engineering curriculum (e.g., Guerra, 2017; Thürer et al., 2018) and integrating the entrepreneurial mindset (Context I of this study; e.g., Bekki et al., 2018; Kriewall, Mekemson, 2010). In this form of change, integrating content in a segment of courses in the curriculum is assumed to represent change at the curriculum-level.

1.4 “Transformation” as a form of course-curricular change

The *transformation* form of curricular change is characterized as one that is built upon extensive debates and negotiations among stakeholders on the purpose of the curriculum and how to achieve this purpose (e.g., Jamieson & Lohmann, 2009). Transformation is associated with the emergence of new issues, the impact of which is not always well-defined (Toombs & Tierney, 1991). While the need for new ways to deal with these issues are clear, “the process of curricular change and the breadth and depth of the challenges in such a setting are different and somewhat unfamiliar” (Toombs & Tierney, 1991, p. 9). This form

of curricular change tends to be largely influenced by external factors that impact the curriculum (Lattuca & Stark, 2009). An example of calls to transform engineering education is the report by the National Science Board to address the emerging needs of the engineering workforce (“NSB”, 2007). Similarly, the *Changing the Conversation* study engaged multiple stakeholders to provide a unique perspective on repositioning the perception of engineering in the society (“NAE”, 2008). Context II in this study (curricular change in response to the COVID-19 pandemic) is an exemplar of this form of change, where the external, global influence of the pandemic is calling for unprecedented efforts for change. Transformative change in Context II has new dimensions of change in terms of breadth and depth, on the curriculum as well as the entire educational process (“ASEE”, 2020). In this form of change, transformation is more than an issue of reorganizing or restructuring the curriculum, as the purpose-means of the curriculum are being redefined (Andersen, 1987). In *transformation* as a form of curricular change, the course-curriculum relationship is more complex as transformation involves the purpose of education in the profession, acceptable pedagogy to match practice expectations, and a larger agenda to address ethical or social responsibility (Toombs & Tierney, 1991).

1.5 Summary

While faculty appear to be making changes at the course-level in both Contexts I and II of this study, their behavior and activities actually exist *as a response* to external change taking place at the curriculum-level. As discussed in this section, faculty course-level efforts in Context I are in response to initiatives in *integration* of EM into the curriculum promoted by

the administration; while faculty course-level efforts in Context II are in response to *transformation* caused by the global pandemic and impacting the entire curriculum. Because the focus in this study is on faculty as they *adapt to change* impacting the curriculum or segments of the curriculum, studying their behavior as they respond to change at the course-level will help answering the research questions in this study.

2. Decision points in the curriculum as an “academic plan”

Different models for academic planning have been developed (e.g., Axelrod, 1968; Dressel, 1971, 1980; Mayhew & Ford, 1971) each calling for incorporating viewpoints from multiple stakeholders in critical decision points affecting the curriculum, short-term and long-term (Conrad & Pratt, 1983). For example, Dressel (1966) identified “specific points of attack in curriculum and course revision,” including course offerings, number of credit hours, course enrollments, overlapping course content and face-to-face hour requirements. In this study, the model of shaping the academic plan as proposed by Lattuca & Stark (2009) is used to study faculty adaptability. The reason for choosing this model is that it looks beyond the planning of curricular elements to address contextual influences on academic plans. Because this study explores faculty adaptability in two divergent contexts, this framing is appropriate.

In Figure 2, eight decision points in academic planning are described. In Table 3, these decision points are mapped to their presence in faculty behaviors in Contexts I and II. These decision points are used in the operationalization of the curriculum as an academic plan in this research design. The connection between each decision point and the two contexts of this study are highlighted. The details of the operationalization of these decision

points in this research design are provided in Chapter 3. More specifically, the mapping between the phases of self-regulation in adaptability and faculty behavior and activities are discussed in-depth as aligned with the eight decision points discussed here.

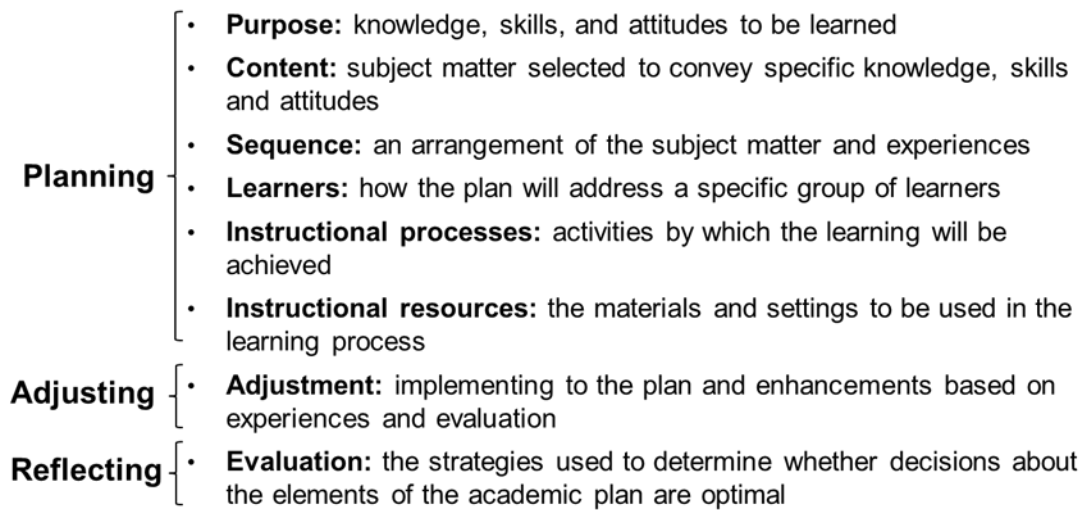


Figure 2. Mapping the elements of the curriculum as an academic plan, as proposed by Lattuca & Stark (2009), to the different phases of adaptability in order to instantiate items relevant to academic contexts for this study.

Table 3. Mapping between decision points in the curriculum as an academic plan and the role of faculty in Contexts I and II.

<i>Decision point</i>	<i>Role of faculty in Context I</i>	<i>Role of faculty in Context II</i>
<i>Purpose</i>	<ul style="list-style-type: none"> Identifying EM learning objectives 	<ul style="list-style-type: none"> Identifying the priority of objectives after the interruption due to the pandemic
<i>Content</i>	<ul style="list-style-type: none"> Selecting EM content to integrate to existing course 	<ul style="list-style-type: none"> Modifying content to match the new teaching modality
<i>Sequence</i>	<ul style="list-style-type: none"> Organizing EM and original content sequence 	<ul style="list-style-type: none"> Organize the content to match the new modality
<i>Learners</i>	<ul style="list-style-type: none"> Determining students' level of understanding of EM Modifying course plan based on level of preparation 	<ul style="list-style-type: none"> Determining level of preparation in new modality Modifying course plan based on level of preparation
<i>Instructional processes</i>	<ul style="list-style-type: none"> Inquiring about suitable method of instruction to integrate EM Choosing and implementing new methods if needed 	<ul style="list-style-type: none"> Inquiring about suitable method of instruction in the new teaching modality Choosing and implementing new methods as needed
<i>Instructional resources</i>	<ul style="list-style-type: none"> Choosing course resources (textbook, media, etc.) to succeed in integration efforts Choosing ways to utilize Learning Management Systems Planning based on class setting (class size, lab setting, etc.) 	<ul style="list-style-type: none"> Choosing course resources (textbook, media, etc.) to succeed in the new teaching modality Choosing ways to utilize Learning Management Systems Planning based on class setting (class size, lab setting, etc.) in the new teaching modality
<i>Evaluation</i>	<ul style="list-style-type: none"> Modifying the course during the semester based on personal observations Modifying the course during the semester based on students' feedback Evaluating effectiveness of integration efforts Assessing the significance of change made by integrating EM into the existing course Reviewing learning outcomes based on integration efforts 	<ul style="list-style-type: none"> Modifying the course during the semester based on personal observations Modifying the course during the semester based on students' feedback Evaluating effectiveness to teach in the new modality Assessing the significance of change made to respond to the new teaching modality Reviewing learning outcomes based on efforts to respond to the new teaching modality
<i>Adjustment</i>	<ul style="list-style-type: none"> Adjusting the plan based on semester progress Allocating time during the semester to modify the integration efforts Identifying aspects of improvement Modifying the course for future offerings Dedicating time to improving the course for future offerings 	<ul style="list-style-type: none"> Adjusting the plan based on semester unfolding, uncertain circumstances Allocating time during the semester to modify efforts to respond to the new teaching modality Identifying aspects of improvement Modifying the course for future offerings Dedicating time to improving the course for future offerings

3. Connections between defining the curriculum as an “academic plan” and other definitions

3.1 Overarching categorization of “curriculum” definitions: As a product and as a process

The definitions provided in Table 4 come from a study by Stark & Lowther (1986) who solicited definitions for a curriculum from different stakeholders in the educational process, including faculty, administrators and external stakeholders. In that study, Stark & Lowther differentiated between a *product* view of the curriculum; that is, one that emphasizes what students should know by the end of the curriculum, and a *process* view of the curriculum; that is, one that emphasizes how the students will acquire the “knowledge, skills and behaviors” in the curriculum (p. 21). In the product view, quality education is aligned with the perspective views of who is an educated person. In engineering education, the Accreditation Board for Engineering and Technology (ABET), as an example, is one organization that sets standards for programs to prepare graduates (“ABET”, 2020). In the process view, while the product is still implied, the emphasis is on the modes of inquiry. In the process view, the role of faculty is amplified as they work on integrating the knowledge into the undergraduate educational experience and accepting the responsibility to achieving the educational goals. As an example, consider the recently published report on *The Global State of the Art in Engineering Education* which concluded that features that distinguish current and emerging leaders in engineering education include “good educational practices highlighted at these institutions [which] included user-centered design, technology-driven entrepreneurship, active project-based learning and a focus on rigor in the engineering ‘fundamentals’” (Graham, 2018 , pp. ii-iii).

Table 4. Some definitions of a curriculum and the embedded role of faculty in each definition.

Definition of a <i>curriculum</i> (Stark & Lowther, 1986; Lattuca & Stark, 2009)	Role of faculty in this definition
1) A mission or purpose of what is important to be learned	Defining the purpose of the program
2) A set of experiences that students should have	Defining and providing the set of experiences
3) A set of courses—offered to students	Creating, organizing and delivery of content
4) A set of courses—that students elect from	Advising students for meaningful and relevant sequence of courses
5) The content of a specific discipline	Defining knowledge content and learning outcomes
6) Time and credit frame of college education	Designing sequence of courses with awareness of the larger context of education

3.2 Integrating product- and process-views: The origin of the “academic plan”

Conceptualizing the curriculum as an academic plan integrates both the product and the process views of the curriculum (Lattuca & Stark, 2009; Stark & Lowther, 1986). The origin of the conceptualization of the curriculum as an “academic plan” comes from Paul Dressel (1965a, 1971, 1976, 1980; Dressel & De Lisle, 1970) who, in a career of over sixty-five years, analyzed college curricula from different perspectives. The culmination of the development of his ideas appeared in his co-authored book *On Teaching and Learning in College* (Dressel & Marcus, 1982). Dressel observed that “the functioning of a curriculum depends, in reality, upon a large number of interrelated factors, many of which are likely to be ignored in developing its rationale” (1965, p. 89). An example of an early indicator to integrate the “product” view of the curriculum and the “process” view appears in his review of the curriculum along the dimensions of courses, quality and costs:

“Although a few individuals have argued that teaching time can be saved by making wider use of independent study, actual experience with this medium regularly demonstrates that it makes heavy demands on the faculty. It becomes apparent, then,

that the route to greater productivity is an increase in the production of student quarter hours. If the course-credit load is to remain the same, this must be accomplished by making the professor responsible for a greater number of students.” (Dressel, 1965b, p. 443)

Although Dressel was at the forefront of synthesizing different perspectives of the curriculum at a time when reassessment of education was taking place, his work yielded little impact on curricular change. According to Stark & Lowther (1986), one reason that his work was not formulated into empirical studies was because he did not attempt to test his ideas other than basing them on “extensive faculty and administrative experience and relationships” (p. 23). Lattuca & Stark attempted to revive his development of academic planning, first by considering the different elements of academic plans (1997) and then by thoughtfully considering the contextual factors within which a curriculum exists (2009).

In their framing of the curriculum as an academic plan, Lattuca & Stark (2009) tried to avoid the shortcoming they observed in Dressel’s work; that is “his normative views [which] did not provide an open framework to guide thinking” (p. 17). While effective and promising, a critique of conceptualizing the curriculum as an academic plan has been that it is a metaphor more than a model (Conrad & Pratt, 1983), and that, in reality, it offers little ability for the decision maker or the stakeholder to recognize all the options or to guide a course of action (Hall, 1989). A parallel alternative to viewing the curriculum as a plan is to describe it as a design that involves making a series of decisions regarding purpose, students, settings and other relationships that meet certain objectives (e.g., Diamond, 2008; Posner & Rudnitsky, 2006; Toombs, 1977--1978; Toombs & Tierney, 1993; Wiggins & McTighe, 2005). However, those taking a design stance on curricular change tend to focus on the

process of planning without emphasis on the larger impact of such plans (for example, on faculty adaptability behavior).

3.3 Curriculum as an academic plan and other definitions: Similarities and differences

Consider the definitions provided in Table 4 before. The first definition on “what is to be learned” can be considered as a “product” definition. This definition seems to be similar to the definition of *purpose* (the first element of academic planning), Figure 2. In the curriculum development literature, this definition aligns with the means-end approaches for the curriculum (e.g., Posner, 1985). While essential, this definition represents only one aspect of viewing the curriculum as an academic plan. In deciding “what is to be learned,” Lattuca & Stark (2009) noted that faculty rely on their “own background, scholarly preparation, teaching experience, and belief about educational purpose” (p. 120). Start et al. (1990) found that faculty report the purpose of the course to be the first step they consider when planning a course. In Context I of this study, faculty integrate the new learning objectives of EM into the course. This is different from just adding new content because entrepreneurship as a mindset should be integrated by choosing suitable class materials that facilitate learning. In Context II of this study, faculty are asked to continue to pursue “what is to be learned” despite the forced changes due to the pandemic. Therefore, faculty will have to make decisions on how to achieve the intended learning goals and if there are compromises that have to be made between what is essential, what is good to know and what is good to be familiar with (Wiggins & McTighe, 2005).

The second definition on “the set of experiences” can be considered as a “process” definition. This definition seems to be similar to the definition of *sequence* (as the third element of academic planning), as well as selecting instructional processes (the fifth element) and instructional resources (the sixth), Figure 2. In the curriculum development literature, this definition aligns with the experience approaches for the curriculum (e.g., Huebner, 1966; Pinar, 1974). This definition describes only some aspect of the curriculum as an academic plan. Faculty play a substantial role in the phases of planning as they develop the interaction between content and actual events that students experience in the curriculum (Ponser & Strike, 1976). In a study of the ways that faculty arrange content, Start et al. (1990) found that faculty follow the relationships that concepts are organized into in the subject matter as well as ways they know students have actually learned. In Context I, sequencing involves introducing basic concepts about EM before integrating them into more complex ones. In Context II, an important factor is involved regarding how faculty knows, in the new modality of learning, that students have actually grasped the present content before moving to the next step.

The third, fourth and fifth definitions on “courses” and “content” can be either “product” or “process” definitions, with the fifth definition focusing on “product.” These definitions seem to be similar to the definition of *content* (as the second element of academic planning), Figure 2. In the curriculum development literature, this definition represents the most substantive element of the curriculum (i.e., courses) as they represent the building blocks of the curriculum (Vallance, 1985). Courses represent the nexus of interaction in the curriculum between the faculty, the student, the subject matter, and the milieu (Schwab,

1973). Faculty play a significant role endorsing certain values of how a course should be taught; e.g., to allow effective thinking (Donald, 2002). In addition, faculty's views of the profession largely influence their approach to course delivery (Cross, 2005; Smart, Feldman, & Ethington, 2000). In Context I, faculty's decisions around content is related to selecting appropriate and relevant course materials to facilitate learning as well as understanding students' level of preparation. In Context II, faculty's decisions around content involves inquiring about ways to effectively deliver course content in the new modality, being aware of course resources and carefully assessing the influence of the new class setting on content and student learning.

The sixth definition on the "time and credit frame of college education" can be considered as a "process" definition of the curriculum. This definition seems to be close to the definition of *purpose* and *instructional processes* (as the first and fifth element of academic planning, respectively), Figure 2. In the curriculum development literature, this definition aligns with concerns around self-actualization of students as learners, the social changes in student's life, and the development of cognitive processes and overall academic achievement (Eisner & Vallance, 1974). However, the particular aspects of time and credit in the curriculum were not thoroughly addressed in the framework of academic plan as developed by Lattuca & Stark (2009) and as used in this research study. They observed that faculty's engagement in these decisions, at the curriculum-level, is sporadic: "Academic values such as professional autonomy, some conjecture, tend to focus faculty member's attention on their own instructional responsibilities rather on program-level curricular planning" (p. 131). In

both Contexts I and II, issues of time and credit frame of college education are beyond the scope of this study.

4. Conceptualizing adaptability as self-regulation

4.1 Self-regulation as a framework: Underlying assumptions

Self-regulation involves the active construction of goals from the given information in the external environment (Azevedo, 2009; Pintrich, 2000; Zimmerman, 1986, 1989, 1990, 1994). It has been used widely in the learning sciences to study mechanisms of learning. Some of the underlying assumptions of self-regulation as a framework is that learners are *active* in constructing goals and attempting to achieving them; that learners have *control* over their learning through their ability to monitor, control and regulate their learning; and that there is *goal or criterion* which provides the standard for assessing regulation. One more assumption underlying self-regulation is that regulatory activities act as *mediators* between the person and the context within which the person exists (Pintrich, 2000). This assumption is particularly important in this study where faculty adaptability is viewed to be context driven.

4.2 Models for self-regulation and link to the study of adaptability

Several models for self-regulation exist. The triadic model in Figure 3, for example, links the person, self-behavior and the environment (Zimmerman, 1989). In a refined model by Zimmerman (2000), self-regulation takes a cyclical phase model, where forethought leads to performance, followed by self-reflection, Figure 4. The Winne and Hadwin model (1998), Figure 5, provides more granularity by including monitoring and control within each phase

of learning while delineating between task definition and goal setting (Greene, & Azevedo, 2007). Pintrich (2000) provides an overview of the common themes of models of self-regulation, where models can be organized along two dimensions: (1) *phases of regulation*, which include forethought (planning or activation); monitoring; control; and reaction (reflection); and (2) *areas of regulation*, which include cognition; motivation; behavior; and context, Figure 6.

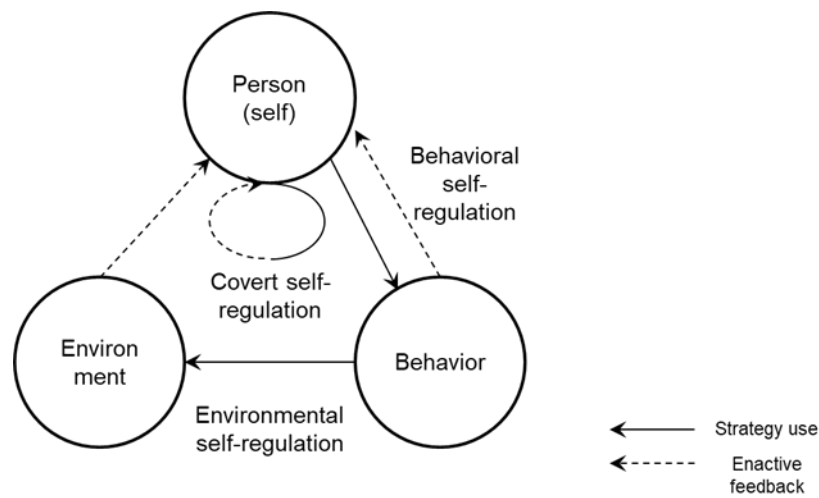


Figure 3. The triadic model of self-regulation (Zimmerman, 1989).

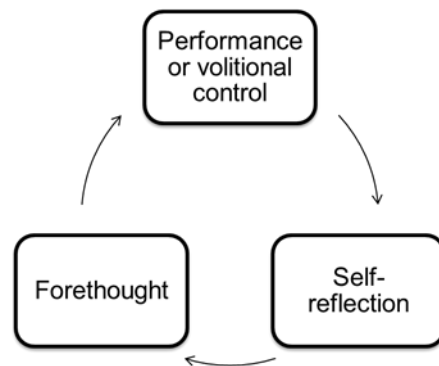


Figure 4. The cyclical phase model of self-regulation (Zimmerman, 2000).

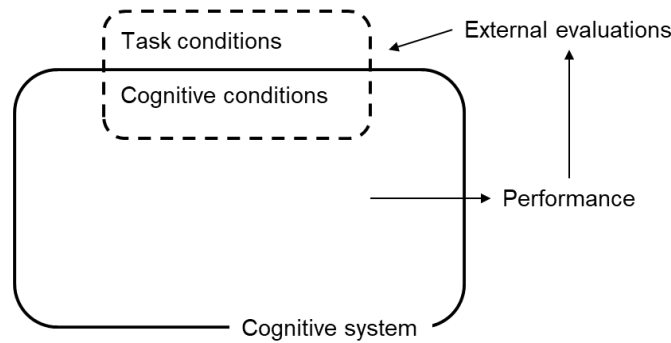


Figure 5. The Winne and Hadwin's model of self-regulation (1998).

		Areas of regulation			
		Cognition	Motivation	Behavior	Context
Phases	Forethought, planning, activation				
	Monitoring				
	Control				
	Reaction and reflection				

Figure 6. Common themes of phases and areas of regulation in models of self-regulation, as proposed by Pintrich (2000). Note that in this categorization, a learner is assumed to either have control of regulating the context or be regulated by the context.

4.3 Proposed conceptual framework

For the purposes of this study, a generic self-regulation model, similar to the one proposed by Zimmerman (2000), is used. The model, however, is modified to include an “adjusting” phase between self-reflection and planning, consistent with the overview of models provided by Pintrich (2000). Because self-regulation involves the monitoring of differences between goals and current states, the study of adaptability as self-regulation is compatible with the

understanding of adaptability as response to change. The model is also modified to include a *willingness* aspect for each phase of the cycle. A similar modification has already been proposed by Zimmerman & Moylan (2009) who observed that individuals in demanding contexts seek personal initiative and involve more motivational aspects than passive engagement. Their modified framework added self-control and self-observation in each phase. In the forethought (or planning) phase, in particular, they added task analysis in self-motivation beliefs as part of the phase. The proposed conceptual framework is visualized in Figure 7.

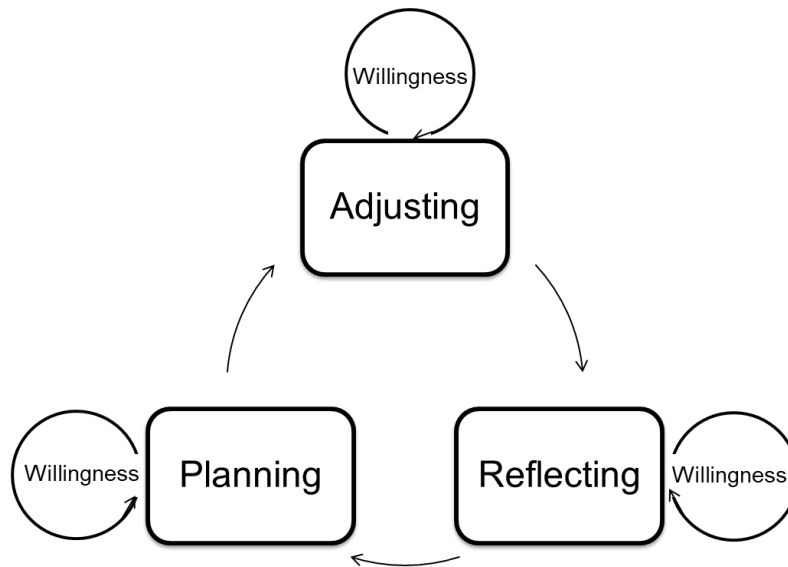


Figure 7. Conceptualization of adaptability as self-regulation in this study.

When conceptualizing faculty's *self-efficacy*, it is more relevant to frame the construct as a combination of faculty's *perceived capability* and *willingness* to act based on that capability. Perceived capability describes "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of

conduct or end-state of existence” (Rokeach, 1973, p. 5). Therefore, in the study of faculty adaptability, perceived capability is operationalized as capabilities that transcend attitudes to guide and determine adaptable actions toward curricular change. In addition, *willingness* is used in framing faculty’s self-efficacy, especially for items related to openness to change. As part of social cognitive theory, *willingness* describes why an individual may venture to fulfill a goal and willingly overcoming failures (Bandura, 1997). *Willingness* connects self-efficacy with outcome expectancy, representing the behavior of an individual based on beliefs of the anticipated outcome (Pintrich & Schunk, 1996). Combining perceived capability with *willingness* in inquiring about faculty’s *self-efficacy* is necessary because faculty are viewed as experts in their domains; inquiring directly about *self-efficacy* may not always provide the intended measures for this study. Noting that *willingness* is an essential component in the proposed framework, in the following discussion, *willingness* and its relevance as a motivational factor is emphasized in each phase (as opposed to being a separate phase by itself).

5. Planning

5.1 Planning as a phase in self-regulation

Planning in self-regulation involves setting some “goal, standard, criterion, or reference value” that guide the regulation process (Pintrich, 2000, p. 472). Self-regulation can be viewed as a process of goal setting, followed by attempts of monitoring, regulation and adjusting. In this understanding, adjusting takes place to guide efforts in order to achieve the set goal. This view is consistent with many of the existing models of self-regulation (e.g.,

Butler & Winne, 1995; Zimmerman, 1989, 1998a, 1998b, 2000). The first three columns of the areas of regulation in Figure 6 highlights the traditional areas of psychological functioning (Snow, Corno, & Jackson, 1996). However, Pintrich (2000) suggested a fourth area of regulation, *context*, in the fourth column.

Planning in the *behavioral* area of regulation has more complex overt aspects compared to other psychological areas of regulation, especially as it interacts with the *context* within which regulation takes place (Pintrich, 2000). In the proposed conceptual framework, the phases of self-regulation are shown to be sequential and time-ordered; however, there is no strong assumption in the models in the literature that a structure, linear progression among phases should be followed. At the same time, planning (sometime referred to forethought and activation) is shown to be the first phase in all models. Goal setting, combined with identifying ways to achieve the goal, act as starters for self-regulation.

Behavioral planning involves significant attention to *time* and *effort* allocation. Planning is conceptualized in models of intentions and intentional planning as a behavioral intention (e.g., Gollwitzer, 1996). In such models, planning represents a formation of intention that is linked to subsequent behaviors (Ajzen, 1988, 1991). *Time* planning and management involves allocating time for the different activities (Pintrich, McKeachie, & Lin, 1987; Simpson, Hynd, Nist, & Burrell, 1997). High achievers in different domains (Zimmerman, 1998a) and self-regulated learners were shown to engage in time management activities (Zimmerman & Martinez-Pons, 1986). During time planning, individuals make decisions on the intensity of *effort* they want to allocate for an activity (Pintrich, 2000).

Different models of planning exist (Maehr & Midgley, 1991; Nicholls, 1984; Pintrich, 1989) and are largely based on theories of achievement motivation (Ames, 1992; Dweck & Leggett, 1988; Wolters, Yu, & Pintrich, 1996). Although all models assume planning to be a function of both individual's attributes and contextual factors, the models differ in their level of emphasis on either one of the two variables. More specifically, the models differ in the degree to which goals in planning are oriented toward the individual's desire for achievement or, alternatively, goals in planning in response to the contextual factors where the individual functions. For example, in Dweck's model, planning can take place to increase competence in an area to either *attain* positive judgment or to *avoid* negative judgement of competence (Dweck & Leggett, 1988). In Ames' (1992) model, planning can take place for goals to develop new skills (mastery goals) or orient oneself to focus on abilities with reference to others (performance goals). In the model by Nicholls and his colleagues, planning can be task-oriented or ego oriented when an individual feels outperforming peers (Nicholls, 1984, 1989; Thorkildsen & Nicholls, 1998).

Overall, goals in planning in self-regulation can be categorized under two categories: *target goals* (Harackiewicz, Barron, & Elliot, 1998; Harackiewicz & Sansone, 1991) and *purpose goals* (Pintrich & Schunk, 1996; Wolters, Yu, & Pintrich, 1996). Target goals are task-specific and represent a specific outcome, whereas purpose goals are general and represent an orientation to achieving a certain level of performance. In curricular change, the work of faculty can best be described as a purpose goal, aligned with views motivation of *why* individuals set goals and evaluate their performance from the perspective of the general orientation to achieving a task. Planning in this sense is not pursued to achieve a specific

number of graduates, for example, or graduates with certain grades (e.g., Locke & Latham (1990); instead, planning from this perspective is related to achievement motivation (Elliot, 1997; Urdan, 1997) in different settings (Pintrich & Schunk, 1996). Because participants in Context I are self-motivated to integrate the EM in their curriculum, as opposed to being forced to implement change as in Context II, the following hypothesis is proposed:

Hypothesis 1. Faculty participants in Context I will have higher “self-efficacy in planning” scores than faculty participants in Context II.

5.2 Relationship between planning and other phases in self-regulation

As discussed before, the sequential, linear nature between phases of self-regulation cannot be assumed. Furthermore, Snow et al. (1996) observed that the boundaries between psychological areas of regulation, Figure 6, are fuzzy. With the focus in this study being on the self-behavior and context, a personal self in the phase of planning focuses on trying to direct the self in terms of “what, how, and when to do a task” (Pintrich, 2000, p. 455). An individual may also attempt to influence contextual features during the planning phases by, for example, redefining task characteristics, identifying feedback systems, or calibrating evaluating structures. Models that view manipulating the context as part of self-regulation (e.g., Sternberg, 1985) do so to the extent that the individual has active control over the context.

Planning, as a phase, interacts significantly with reflection. Although planning and reflection share that they both can be considered as cognitive processes, they both also have behavioral aspects. For example, reflection on time spent on a task and outcome achieved involves the behavioral act of comparing the achieved outcome to the desired goal.

Individuals observe their behavior and monitor their progress toward achieving their set goals through various methods (Zimmerman, 1998a, 2000). The link between planning and reflection usually is defined during the planning phases when individuals decide on ways to monitor and record their progress (Zimmerman, 1998b). Making the decision to evaluate progress requires planning to acquire feedback information in an attempt to monitor and implement changes to achieve the goal (Pintrich, 2000). Similarly, making the decision based on acquired feedback involves reallocation of future time and effort.

Planning also interacts with adjusting, as two phases in self-regulation. An individual may regulate time and effort behaviors based on the difficulty of the task. Pintrich (2000) described this regulation as “general persistence” which has been linked to an indication of motivation. Adjusting regulation in order to achieve a goal can directly imply an increase in effort (defensive pessimism) or decrease in effort (self-handicapping) (Pintrich, 2000). Adjusting efforts to achieve goals may also involve seeking help (Nelson-Le Gall, 1981, 1985) which can also be considered a form of adjusting the context (Ryan & Pintrich, 1997).

5.3 Planning in curricular change

Courses represent the building blocks of the curriculum. The difference in planning at the course-level and the curriculum-level is related to the actors, processes and influences (internal and external) between the two levels (Lattuca & Stark, 2009). Noting that change in both Context I and Context II affects the entire curriculum, the traces of global impact of change at the curriculum-level can be mapped to the local change at the course-level; the discussion below will focus on the course-level planning.

Course planning characterizes “decision making about the selection, organization, and sequencing of routines” (Yinger, 1979, p. 165). Although course planning is central to the educational process, little research has been conducted in higher education to understand faculty activities in planning college courses (Stark, 2000). According to Lattuca & Stark (2009), “our understanding to planning processes used by college instructors is far from complete,” however, “we know that a step-by-step or rational planning model does not seem to describe their actual planning behavior” (p. 117).

Differences exist between planning for an existing course or planning for a new course. An early study by Powell & Shanker (1982) observed that faculty at the college level do not spend significant time planning for an existing course. They found that faculty tend to use fine-tuning techniques and adjusting the course as needed. The dominant pattern for planning of an existing course has been described as “routine course planning” (Stark & Lowther, 1988). While frameworks for course planning suggest a systematic process, research shows that such frameworks are different from what faculty actually do (Lattuca & Stark, 2009). In contrast to planning for an existing course, planning a new course or significantly modifying an existing course takes more effort (Stark, 2000) but has been found to be less frequent (Stark et al., 1988).

5.4 Mapping planning as a phase in self-regulation to adaptability in curricular change

Planning in self-regulation represents the first phase of the response to change progression. In the literature on self-regulation, planning involves setting goals and devising ways to manage time and effort to achieving these goals. In the literature on adaptability, planning

has been conceptualized as process to find a fit between an individual's behavior and the novel context they face (Chan, 2000) and as ways to engage in acquiring new information about emergent states that require new type of performance (Baard et al., 2014). *Planning* during adaptability involves the development of new capabilities (Kozlowski et al., 1999) and recognizing the change in the previously familiar elements and the emergence of new elements in the context (Burke et al., 2006; Rosen et al., 2011). As was discussed before, motivation plays a major role in planning (e.g., Ames, 1992; Dweck & Leggett, 1988) especially as planning in self-regulation is motivated by the desire for achievement.

As illustrated in Figure 2, faculty engage in six aspects of planning during curricular change (Lattuca & Stark, 2009). These aspects form the basis for the instantiations of items in the instrument developed for this research design. Purpose is instantiated by inquiring about the learning objectives: *"I was able to successfully identify appropriate learning objectives for this course."* Content is instantiated by inquiring about course material: *"I was able to select appropriate course materials to facilitate learning."* Sequence is instantiated by inquiring about the organization of the material: *"I was able to organize content such that basic concepts were introduced first before integrating them into more complex ones."* Planning for learners is instantiated by inquiring about the understanding preparation level: *"I was able to determine students' level of prerequisite preparation"* and *"I was able to modify my class plan to address students' preparation."* Planning for instructional processes is instantiated by inquiring about methods of instruction: *"I was open to inquiring about methods of instructions that influence students' learning"* and *"I was open to implementing methods of instruction that are new to me."* Planning for instructional resources is instantiated by inquiring about course resources: *"I was open to changing course*

resources (e.g., textbook, media) in order to succeed in my effort in this course” and “I was able to plan the course based on the selected course Learning Management Systems (e.g., Blackboard, Canvas, etc.);” and based on class setting: “I was able to plan the course based on the class setting (e.g., class size, lab setting, etc.).”

6. Adjusting

6.1 Adjusting as a phase in self-regulation

Adjusting as a phase in self-regulation represents the individual’s control and regulation of behavior. Strategies for adjusting take many forms: while an individual may aim to regulate time and effort (as discussed when talking about planning), an individual may attempt to control other work behaviors or activities, health behaviors or social relationships (Pintrich, 2000). *Adjusting* has the aspect of persistence (Karabenick & Sharma, 1994) and is an indicator for motivation (Nelson-Le Gall, 1981, 1985). The link between *adjusting*, as a behavioral area of regulation, and motivation, as an affective area of regulation, can be explained as an attempt to “control anxiety and self-worth” (Pintrich, 2000, p. 468) in anticipation of reward or in avoidance of consequences (Weiner, 1986; Zimmerman & Kitsantas, 1997). *Adjusting* can also take the form of contextual control (Zimmerman, 1998a). An example is *adjusting* that takes the form of help-seeking (Newman, 1991, 1994), where the behavior is directed toward social interaction as a way for contextual control (Ryan & Pintrich, 1997). In models of volitional control, controlling the context is usually referred to as environmental control (Pintrich, 2000), where the individual seeks to control the structure of the environment (Corno, 1989, 1993) to achieve goals and complete tasks (Kuhl, 1984,

1985). Furthermore, in constrained contexts, an individual may seek to negotiate the task as a way to regulate the context (Doyle, 1983).

In work and teaching environments, *adjusting* is the center of action, where individuals actually perform and deliver tasks. Different contexts provide different levels of autonomy, allowing individuals to bear different responsibilities (Blumenfeld, et al., 1991). The variations in the degree of autonomy entail variations in the opportunities for *adjusting* in self-regulation (Brown, 1997). For example, a context that encourages discourse, critical thinking and the experimenting of new projects will result in differences in ways of *adjusting* and development compared to constrained contexts that do not provide multiple opportunities for behavioral and contextual control (Pintrich, 2000). The freedom to *adjust* one's context provides more ability to control and regulate the context (Hofer et al., 1998; Zimmerman, 1998a).

Adjusting as a phase that follows planning has the attribute of being a reactive behavior (Brown, 1997) and, in multiple cycles of self-regulation, it is described as iterative behavior (Pintrich, 2000). The cyclical nature of self-regulation is manifested in the individual's effort to *adjust* performance in order to achieve goals (Zimmerman, 2000).

Adjusting as a reaction, therefore, depends on previous knowledge states and metacognitive views (Zimmerman, 2000). Zimmerman (1995b) observed that, in the reaction process, adjusting depends on both self-beliefs and affective reactions; contexts that promote confidence tend to inspire more agency in *adjusting* in future cycles of self-regulation compared to contexts that promote doubts and fears. Uncertain contexts impact the ability

for self-processing to adjust as well as perceived efficacy (Bandura, 1997; Pajares & Miller, 1994; Zimmerman, 1995a).

Overall, behavioral *adjusting* involves changing performance as a result of continuous monitoring of conditions and outcomes. The phase illustrates the active agency in self-regulation, and it is a covert phase of self-regulation where the individuals externalizes the change in performance. *Adjusting* can be characterized as being reactive to the changes, when individual compares outcomes to a well-established standard (Locke, 1991), or it can be characterized as being proactive, when an individual aims to increase performance, raise goals or seek more demanding challenges (Zimmerman, 2000). *Adjusting* involves both self-control (to act based on planning and reflection) and self-observation (to promote future plans and reflections) (Schunk, 1982; Meichenbaum, 1977). Clarity of cues regarding task-related responsibilities will promote the self-observation. By observing outcomes of performance in multiple iterations of self-regulation, an individual may start observing recurrent patterns that may result in attempts to either alter the behavior or modify the environment (e.g., Bonner, Rivera, & Zimmerman, 1997). Therefore, because Context I is described as one that has more clarity and consistency, and less constraints and consequences compared to Context II, the following hypothesis is proposed:

Hypothesis 2. Faculty participants in Context I will have higher “self-efficacy in adjusting” scores than faculty participants in Context II.

6.2 Relationship between adjusting and other phases in self-regulation

Adjusting is described in self-regulation models in the literature as performance or a volitional control process (Panadero, 2017; Pintrich, 2000; Zimmerman, 2000). As a phase, *adjusting*

involves both self-control and self-observation (Zimmerman, 2000). Self-control interacts with the *planning* phase as attention focusing, in which concentration is attuned to aspect of the self and the environment that can be controlled or manipulated (Mach, 1988). Self-control in adjusting involves the behavior of ignoring distractions (Kuhl, 1985) and knowing how to concentrate on relevant external events (Corno, 1993; Weinstein, Schulte, & Palmer, 1987). The interaction between *planning* and *adjusting* is exemplified by identifying strategies that are essential to the successful completion of the task (Weinstein & Mayer, 1986), and by limiting, during *planning*, the number of aspects of the task to focus on while *adjusting* (Wood, Woloshyn, & Willoughby, 1995; Zimmerman and Martinez-Pons, 1988).

In addition to *planning* in self-control, *adjusting* also involves self-observation as the individual tracks aspects of performance (Zimmerman & Paulsen, 1995). During actual behavior, the delineation between *adjusting* and monitoring (or *reflecting*) is hard to make (Zimmerman, 2000); especially with higher levels of expertise where concurrent *adjusting* and monitoring takes place at a more fine-grained level compared to novices (Mach, 1988). Furthermore, during *planning*, an individual may select to monitor and *reflect* on certain features of performance (Zimmerman, 2000). In a refined model of self-regulation by Zimmerman & Moylan (2009), the performance phase was modified by including metacognitive monitoring to the performance phase. Overall, in the various models of self-regulation, changes in the names of phases (e.g., Kuhl, 2000; Panadero, 2017; Schmitz and Wiese, 2006) indicate the interactive nature between the phases and the corresponding processes.

6.3 Adjusting in curricular change

Adjusting in curricular change involves the development, coordination, implementation, support and evaluation of change in the curriculum from different stakeholders (Lattuca & Stark, 2009). In the following discussion, the focus is on the role of faculty to develop, implement and evaluate adjustments in the curriculum. The term *adjusting* encompasses many activities that faculty engage in during the process of change, Table 5. In the conceptualization of the two contexts of this study, change is viewed to be initiated by an external entity: in Context I, by the interest of the administration to integrate EM into the engineering curriculum; and in Context II, by the global pandemic. Both contexts represent a common identified initiation of change for the curriculum which is initiated or facilitated by an entity external to faculty, and where faculty are expected to respond to the change (i.e., adapt) (Hecht et al., 1999; Leaming, 2007; Lucas, 1994; Tucker, 1992).

Table 5. Curriculum administration functions as they relate to the responsibilities of faculty. Adapted from Lattuca & Stark (2009, p. 272).

Aspect of change	Development	Implementation	Evaluation
<i>Aspect of the curriculum</i>	<i>Purpose, Content, Sequence</i>	<i>Learners, Resources, Process</i>	<i>Evaluation, Adjustment</i>
Change functions (faculty roles)	<ul style="list-style-type: none"> • Keep abreast of trends in field • Design program plans and courses • Describe and communicate plans 	<ul style="list-style-type: none"> • Deliver courses • Understand learners • Select materials • Select processes 	<ul style="list-style-type: none"> • Monitor student progress • Monitor progress of change deployment • Determine merit and worth • Determine costs/benefits • Adjust plans • Report to Chair, Dean

When faculty plan on responding to change, their adjustment efforts, according to Lattuca & Stark (2009), follow a “competing values” model for change. The competing values model has a dimension of flexibility control that represents the tension that faculty face in response to change: tension between the autonomy in creative implementation of change and the accountability to the sponsors of change and to the students (Quinn, 1988; Quinn et al., 1990). A context that motivates shared responsibility, creative experimentation and a sense of both ownership and support is a context that tends to minimize the tension that faculty face. Supportive contexts enable flexibility in responding to faculty’s professional needs during change (Guskin, 1981). Clear and consistent communication from the administration enhances the understanding by faculty of their role in curricular change (Schuster & Finkelstein, 2006). A shared understanding of the reward system (i.e., consequences) can establish an increased interest by faculty to being engaged in *adjusting* to the new curricular needs (Cochran, 1989; Gray, Froh, & Diamond, 1992). In a study of a faculty sample in different types of national institutes and universities, Fairweather & Rhoads (1995) concluded that faculty perceptions of the academic context have significant influence on their willingness to adjust behavior.

Faculty can feel empowered to implement change when significant attention is given to their efforts by the administration, beyond focusing only on budget and scheduling when discussing the curriculum (Stark & Briggs, 1998). An example of openness in communicating expectation was illustrated in the University of Utah where a shared matrix of objectives was developed, in alignment with a statement of purpose. Every course was expected to achieve at least one objective, and faculty were asked to develop a teaching philosophy for that

objective in the selected course (Lattuca & Stark, 2009). Overall, with the competing demands being asked from faculty members, developing, implementing and evaluating effective *adjusting* in curricular change can be successful when recognized as a shared responsibility (Davis et al., 1982), that gives special attention to the learners (Astin, 1979), and where goals are periodically discussed and continuously valued (Stark, 2002).

6.4 Mapping adjusting as a phase in self-regulation to adaptability in curricular change

Adjusting as a phase illustrates the underlying assumption in self-regulation models that an individual has control over their own behavior as well as the context (Pintrich, 2000). In addition, *adjusting* as a phase illustrates the assumption that an individual can establish a goal and work toward achieving it while monitoring one's progress (Miller, Galanter, & Pribram, 1960). Adaptability, as the willingness to change behavior in response to change, is reflected in the behavior that an individual exhibits in the response to change (Pulakos et al., 2000; Pulakos et al., 2002). In curricular change, faculty are involved in the development, implementation and evaluation of change efforts, as in Table 5 (Lattuca & Stark, 2009). Efforts such as modifying a course plan based on new trends in the field, selecting class materials and adjusting plans as needed are exemplars of the faculty effort to adapt in curricular change. Context characteristics has been shown to play an important role in faculty's ability to *adjusting* behavior (Cochran, 1989; Gray, Froh, & Diamond, 1992; Rhoads 1995) and overcoming situational barriers (Dancy & Henderson, 2010).

In the design of this research, the mapping between *adjusting* in self-regulation and adaptability in curricular change is operationalized across the two contexts of this study by

using items that inquire about *adjusting* to change *during* and *after* the semester of interest. Items that inquire about change *during* the semester instantiate adjusting as it relates to course plan: “*During the semester, I was able to adjust the course plan as needed as the semester was unfolding;*” and time allocation for adjustment: “*During the semester, I was able to allocate time to modify plans as the semester was unfolding.*” Items that inquire about change *at the end of the semester* instantiate adjusting based on aspects of improvement: “*I was able by the end of the semester, to identify which aspects of the course need improvement;*” instantiate adjusting based on making modifications in future offerings: “*I was able by the end of the semester, to modify the course for future offerings based on things that I identified as in need of improvement;*” and instantiate adjusting based on allocating time to make improvements: “*I was able by the end of the semester, to dedicate time to improve my future offering of this course.*”

7. Reflecting

7.1 Reflecting as a phase in self-regulation

In the literature on self-regulation, reflecting has been described as self-monitoring, self-evaluation and self-consequences (Zimmerman, 1998a). Self-monitoring involves observing one’s performance, assessing outcomes with respect to goals (Baker 1979; 1989; Schneider & Pressley, 1997; Schraw et al., 1995). Self-evaluation is similar to self-monitoring but has the extra feature of setting standards and using them in the assessment of performance (Zimmerman, 1998a). Self-consequences refer to establishing rewards contingent upon the level of accomplishment (Weiner, 1986; Zimmerman & Kitsantas, 1997) and is linked to deeper cognitive understanding of learning and achievement (Pintrich & Schrauben, 1992).

More broadly, self-monitoring can be defined as the “act of recording or rating one’s own behavior” (Webber et al., 1993, p.38). In this definition, the act of rating indicates the active agency of the individual to monitor performance. Although reflecting can be merely a cognitive activity (Pintrich, 2000; Zimmerman, 1998b), highlighting it by introducing the rating aspect makes it a distinct phase of self-regulation (Schmitz & Perels, 2011; Shapiro, 1984).

In self-regulation, the rating aspect in the *reflecting* phase does not necessarily mean to quantitatively include measures in the reflection; instead, it indicates the externalization of reflection from the cognitive domain into the behavioral domain (Pintrich, 2000). This can take many forms that leads subsequently into attempts to regulating the effort, adjusting the behavior as the activity is taking place and as the events are unfolding (Zimmerman, 1998a, 2000). *Reflecting*, therefore, becomes a more active and engaging phase, consistent with the underlying assumption of active agency of self-regulation (Azevedo, 2009; Pintrich, 2000; Zimmerman, 1986, 1989, 1990, 1994). Zimmerman (1998a) studied the monitoring phase among individuals with different areas of expertise. He observed the writers monitor their performance by keeping records of literary production; athletes grade themselves after each match; musicians listen to self-recording and continue practicing until there are no flaws in the played piece; and high-achieving students check work before handing it in to the teacher.

Reflecting as monitoring in self-regulation can be considered to have the two components of reflecting *in* action, and a deeper, retrospective contemplation of practice; that is, reflecting *on* action (Schon, 1984). Reflecting in action requires heightened levels of awareness of both the task being undertaken and the context within which it takes place

(Pintrich, 2000). An environment that enables self-observation (Zimmerman & Martinez-Pons, 1986) and self-experimentation (Zimmerman, 1998a, 2000) during the activity is usually an environment that induces effective self-monitoring. Awareness, usually described as contextual monitoring, allows the comparison between contexts and the adjustment of behavior accordingly (Hofer, Yu, & Pintrich, 1998; Simpson et al., 1997). An increased level of awareness to the explicit cues provided by the context provides “psychological pressure” to pursue a particular course of action (Meyer, Dalal, & Hermida, 2010). In this study, the features of Context II are characterized by emergent and uncertain attributes compared to the features of Context I. Because of the lack of clarity and the higher level of uncertainty in Context II, assessment of the task and the context may not be fully achieved compared to monitoring of both the self and context in Context I (Hattrup & Jackson, 1996; Mischel, 1973, 1977; Snyder & Ickes, 1985). Therefore, the following hypothesis is proposed:

Hypothesis 3. Faculty participants in Context I will have higher “self-efficacy in reflecting” scores than faculty participants in Context II.

7.2 Relationship between reflecting and other phases in self-regulation

Reflecting as monitoring in self-regulation transcends being a separate phase in a linear sequence in the cycle; it is an integral part of *planning* and *adjusting*. As a matter of fact, the original model of Zimmerman (2000), which forms the conceptual basis for the framework of this study, has been modified by Schmitz and colleagues with changes in the names to emphasize self-monitoring in self-regulation (Schmitz, Klug, & Schmidt, 2011; Schmitz & Wiese, 2006). Their work was influenced by Kuhl (2000) who compared the relationship between beliefs and performance, asserting that beliefs are consequences of performance,

not causes for performance. The discussion highlights the highly interactive nature between *reflecting* and other phases of self-regulation.

Furthermore, in a revised model of self-regulation by Zimmerman (1998a), monitoring is present in three of the four phases of self-regulation as follows: Strategy implementation and monitoring—Strategic outcome monitoring—Self-evaluation and monitoring. According to Zimmerman & Martinez-Pons (1986), awareness, as part of *reflecting*, forms the basis of self-regulation, before *planning*. When an individual is aware of their skills in reference to the demands of the context, they start developing a sense of what to do and how to respond. Similarly, in the Dual Processing model developed by Boekaerts & Cascallar (2006) awareness of tasks triggers goal orientation and which goals to pursue.

Reflecting is also considered to be interacting with the *adjusting* phase. In the framework developed by Pintrich (2000) for the phases and areas of self-regulation, “reaction and reflection” are considered to be one phase. Similarly, in the Dual Processing model, monitoring the task may trigger cognitions and emotions that may move the individual to act to pursue other goals (Boekaerts, 2011). Monitoring in this case may trigger *adjusting of behavior*, “expanding knowledge and skills,” or *adjusting of plans*, “protecting threat to the self [...] and protecting one’s commitments” (pp. 410-411). Overall, the boundaries between the phases is fluid, and the proposed delineation is used to operationalize different aspects of adaptability.

7.3 Reflecting in curricular change

Reflecting in curricular change is called, at the course level, the evaluation of teaching and student learning outcomes, and is called, at the curriculum level, program evaluation (Lattuca & Stark, 2009). In the education literature, reflection is a process that is incorporated in efforts of assessment, review and evaluation. *Assessment*, as a term, is usually associated with learning outcomes as they relate to instructional processes, whereas *review* and *evaluation* are used for broader activities such as self-study and program review (Stark & Thomas, 1994). The process involves comparing effectiveness of a course or a curriculum in achieving a defined outcome, with attention to interaction between the different elements of the educational process (Lattuca & Stark, 2009).

Evaluation strategies in education take many forms, depending on the data collected for evaluation and the purpose of evaluation. Evaluations can be *informal* where a faculty selects a purpose for evaluation (e.g., content, sequence or instructional process) and request prompt feedback from students in the classroom (Costin, Greenough, & Menges, 1971). Evaluations can be *student-centered* in that they seek the feedback from students in a structured way (e.g., surveys, interviews and focused groups) to understand students' expectations in comparison to the faculty expectations (Wright, 2011). Evaluations can be *goal-free* in that they seek to understand the students' academic experience holistically without pre-articulated specifications from faculty about the intended learning objectives (Lattuca & Stark, 2009). In this form of evaluation, the involvement of faculty requires openness to all unintended outcomes. Lastly, evaluations can be *goal-focused assessments* in that they focus on empirical evidence to assess student learning with respect to intended learning outcomes (Stark, 1990).

Faculty may reflect on their own teaching for many reasons, including guiding students' progress; improving course planning; enable discussions with other faculty on course outcomes; educate students about various aspects of the course; and to show responsibility toward assigned teaching tasks (Lattuca & Stark, 2009). In a study of faculty's assessment process for course planning, Stark et al. (1988) found that faculty use four ways to assess their teaching: faculty practice professional judgement as an indicator for the effectiveness of their teaching; faculty solicit students' opinions about the course; faculty evaluate students' performance in the course (using examinations results and other indicators); and faculty seek the opinion of peer faculty to judge the course. When faculty practice professional judgment to observe student involvement in learning, they use one of the indicators described in Table 6.

Table 6. Indicators faculty use in “professional judgement” of student learning. (Starks et al., 1990)

<i>Indicator</i>	Percent of faculty with 95% confidence in indicator
<i>Examination results</i>	62
<i>Student papers</i>	51
<i>Observing discussions and student participation</i>	50
<i>Completion of assignments</i>	47
<i>Watching student faces</i>	46
<i>Class attendance</i>	40
<i>Observing after-class discussion</i>	21
<i>Student evaluations</i>	21
<i>Number of office visits</i>	15
<i>Student journals</i>	8

In addition to professional judgement, faculty seek students' opinions. There are many variations for this strategy, including consulting with outside unit (like an evaluation office on campus) or directing an evaluation session with another faculty member (Tiberius,

1995). When faculty use student achievement as a way to assess their teaching, different views exist as to what achievement means especially in courses that focus on problem-solving and behavioral skills (e.g., Dym et al, 2005).

Overall, the practice of faculty reflection on their teaching can be enhanced by incorporating findings from research on classroom assessment (Angelo, 1991; Cross 1998). This includes using effective ways of describing learning outcomes (Banta & Schneider, 1988) and measures of students' change (Pace, 1985). In addition, consulting faculty peers in reviews of class has been found to be a successful model (Hutchings, 1995; 1996). More importantly, the ultimate purpose of *reflecting* is to adjust teaching performance; acting based on these reflections is associated with enhanced future reflections (Lattuca & Stark, 2009).

7.4 Mapping reflecting as a phase in self-regulation to adaptability in curricular change

As discussed before, adaptability represents the ability to respond to change. *Reflecting* as a phase in self-regulation characterizes an important aspect of that change as the events unfold (in order to lead to adjusting of behavior; that is, *reflecting* in action) *and* after change has taken place (in order to induce another cycle of self-regulation; that is, *reflecting* on action). *Reflecting*, as was discussed, represents the active agency assumption of self-regulation where the individual constantly monitors the context and is aware of change taking place (Burke et al., 2006; Kozlowski et al., 1999; Kozlowski et al., 1996). *Reflecting* addresses the change by encouraging an iteration in the self-regulation cycle which is based upon enhanced understanding of the performance-outcome relationship (Baard et al., 2014). As faculty

engage in reflecting about curricular change, they exhibit a dynamic aspect of the educational process that is responsive to the needs of the existing contexts (Lattuca & Stark, 2009).

In the design of this research, the mapping between *reflecting* in self-regulation and adaptability in curricular change is operationalized across the two contexts of this study by using items that inquire about reflecting on change *during* and *after* the semester of interest. Items that inquire about change *during* the semester instantiate the reflecting on personal efforts: “*I considered it important to reflect on my effort to modify this course during the semester;*” and on student feedback: “*incorporate changes to the course based on student feedback during the semester.*” Items that inquire about change *at the end of the semester* inquire instantiate reflecting on effectiveness: “*At the end of the semester, I was able to evaluate the effectiveness of changes I made in this course;*” on significance of change: “*At the end of the semester, I considered the changes I made in my course to be significant;*” and on learning outcomes: “*At the end of the semester, I considered it important to review the impact of changes on the learning outcomes.*”

8. Conceptualizing contexts

8.1 Context’s situational strength as a framework

In organizational theory, a context is conceptualized by the strength of the characteristics that define it as a situation; i.e., “situational strength” (Hatrup & Jackson, 1996; Hough & Oswald, 2008; Murphy & Dzieweczynski, 2005). Various contexts have various characteristics. Meyer, Dalal, & Hermida, (2010) provided a framework that categorizes contexts based on four facets: constraints, consequences, clarity and consistency. The facets were derived deductively based on their review of the literature in the situational strength’s

construct space. Table 7 provides definition of the four categories as they are operationalized in this study. In this study two contexts are examined to understand their effect on faculty adaptability: Context I is characterized as being *prescribed* in terms of the required curricular change with *interdependence* in the social system during the implementation; and Context II is characterized as *emergent* in terms of curricular change with *uncertainty* during the implementation. In the following sections, characterizations of each context are provided.

Table 7. Operational definitions for facets of the framework characterizing contexts (Meyer et al., 2010).

Context facet	Definition (Meyer et al., 2010)
Clarity	“the extent to which cues regarding work-related responsibilities or requirements are available and easy to understand”
Consistency	“the extent to which cues regarding work-related responsibilities or requirements are compatible with each other”
Constraints	“the extent to which an individual’s freedom of decision and action is limited by forces outside his or her control”
Consequences	“the extent to which decisions or actions have important positive or negative implications for any relevant person or entity”

8.2 Context I—Integrating the entrepreneurial mindset in the engineering curriculum

Efforts to cultivate the entrepreneurial mindset (EM) among engineering students have increased over the past decade (London et al., 2018). Most prominent is the Kern Family Foundation (KFF) initiatives to integrate EM within the engineering education ecosystem. The foundation provides support for the Kern Engineering Education Network (KEEN)—a partnership between 28 institutes with the shared vision to instill the EM among the new graduates. As such, the KEEN approach includes activities around curriculum development,

faculty workshops and student engagement (e.g. Fry & Van Treuren, 2016; Rayess, 2016; Thoroughman et al., 2014; Gerhart et al., 2014; Riofrio et al., 2015; Condoor & Mcquilling, 2009). The KEEN approach to integrate EM in the engineering curriculum represents an ideal exemplar for Context I in this study in terms of being *prescribed with interdependence* during implementation for the following reasons:

1) *A self-directed effort*

In this context, a faculty member chooses a candidate course and the application of EM in its context. The faculty leads the effort, with coaching and consulting in guiding the integration of EM in the course (“KEEN”, n.d.1).

2) *Results are bounded and controlled*

Although efforts in this context attempts to trying something new, the elements being integrated (that is, EM and the traditional engineering content) are well-defined with specified elements that can guide the acquisition of new skills and the anticipation of results. The real value results from the combination and integration of well-known contents (“KEEN”, n.d.2).

3) *Development, deployment and assessment follows a structured process*

Participants in the program engage in well-defined, structured process of consultation, coaching and mentorship. Faculty members are supported with clear strategy to achieve and

sustain outcomes. Successful practices are shared, promoted and strengthened within communities of practice that meet regularly to discuss achievements (“EFIC”, n.d.).

4) *A member of a community*

Participating in Context I is voluntarily. There are incentives for participating, but it is not required. A faculty member may decide to choose a community of 3,500 faculty members who are engaged in the network with the KEEN partnership. Here, effectiveness of one faculty member, as an individual, has an impact on other peers and the organization as a whole. Effectiveness here is measured by how well the work of the individual is embedded in the curriculum. In this context, activities of faculty are interdependent and there is a complex link between behavior and effectiveness. While the traditional activities of faculty can't be defined as either totally independent nor totally interdependent, activities in this particular context are largely interdependent. For example, a faculty member may adjust behavior to collaborate with another faculty member for the success of the EM effort, even when this collaboration may not benefit the first faculty member directly. Measuring the relative importance placed on the new behaviors is key (Chan, 1998).

5) *Professional development that integrates prior teaching practices with new ones*

Faculty engagement in Context I can best be described as a professional development activity. Adaptability, in this sense, has a significant learning component (“KEEN”, n.d.1)

8.3 Context II—Curricular change in response to the COVID-19 pandemic

The impact of the COVID-19 coronavirus pandemic on education, in general, and on engineering education, in particular, has been significant. The situation, started in Spring 2020, caused suspension of in-person classes and disrupted regular instruction. Furthermore, it tested the adaptability and resilience of all members of the educational community, just as it did for the entire globe. Assessing the impact of this crisis is still on-going and studies continue to be prepared to analyze and understand the complicated consequences of this trauma (“ASEE COVID”, 2020). The context of COVID-19 pandemic and its impact on the engineering curriculum represents an ideal exemplar for Context II in this study in terms of being *emergent with uncertainty* during implementation for the following reasons:

1) *Fast-paced*

Broadly speaking, organizations need to adapt quickly in the face of uncertainty. Context II is a unique illustrative of fast-paced adaptation.

2) *Unpredictable, with no pre-conceived characterization of the consequential change*

Uncertainty is dominant in this context. While faculty can be described as experts in their fields, a major contributing factor to the difference in this context is not the role of expertise; instead, it is the sudden change that occur in Context II without previous warning.

3) *Lacking clear strategy for appropriate response*

Uncertainty in Context II occurs without a clear strategy on how to move forward.

Resources, networks and access may not be readily available; change in Context II happens without clear and prior articulation of the implications of response decisions for change.

This results in the continuous anticipation for the unexpected.

4) *Strong top-down control*

Counterintuitively, in Context II in academia, control from the administration is increased to deliver the expected service from faculty.

5) *Requires emergent learning of new skills*

In responding to the circumstances in Context II, many faculty will need to learn new skills.

The demand of the situation requires transferring previous approaches of teaching to adapt to the new context. The process may imply taking advantage of the context as an opportunity to try new pedagogies to be sustained beyond the context.

9. List of hypotheses

Based on the previous literature, the visual model representing the hypothetical relationships in this study is provided in Figure 8 and Figure 9 below. The representation provides an illustration of the numbered relationships. A summary of the list of hypothetical relationships to be tested is included below.

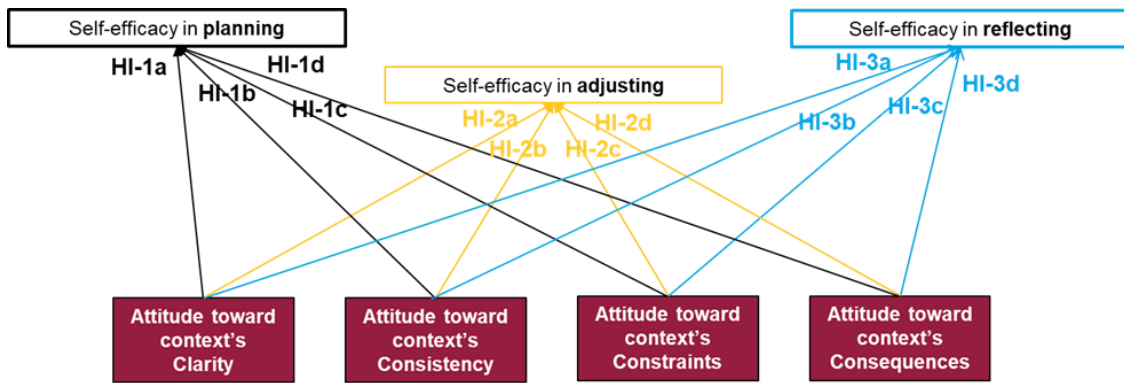


Figure 8. Context I: Hypothetical relationships between attitude toward context (as predictors) and dimensions of adaptability (self-efficacy in self-regulation).

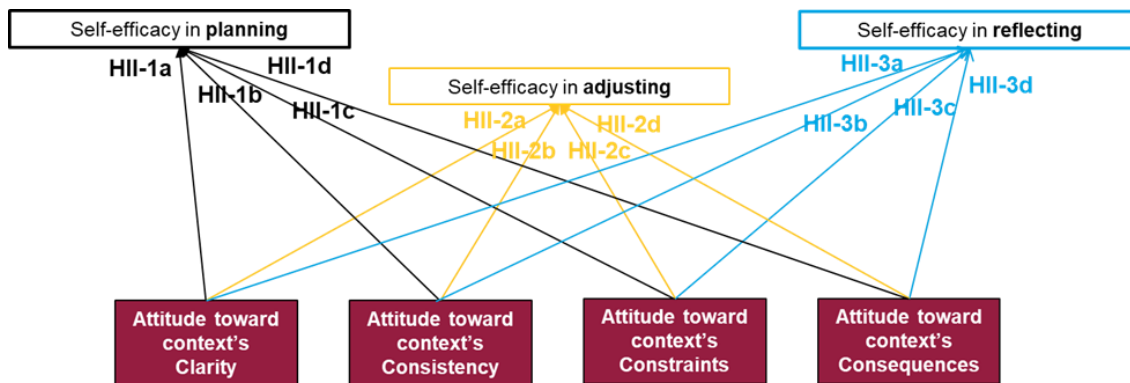


Figure 9. Context II: Hypothetical relationships between attitude toward context (as predictors) and dimensions of adaptability (self-efficacy in self-regulation).

Table 8. Comparison between the dependent variables across Context I and Context II.

Self-efficacy in planning
<i>Hypothesis 1.</i> Faculty participants in Context I will have higher “self-efficacy in planning” scores than faculty participants in Context II.
Self-efficacy in adjusting
<i>Hypothesis 2.</i> Faculty participants in Context I will have higher “self-efficacy in adjusting” scores than faculty participants in Context II.
Self-efficacy in reflecting
<i>Hypothesis 3.</i> Faculty participants in Context I will have higher “self-efficacy in reflecting” scores than faculty participants in Context II.

Table 9. Comparison between the independent variables across Context I and Context II (based on characterization of each context).

Attitude toward context’s clarity
<i>Hypothesis 4.</i> Faculty participants in Context I will have higher “attitude toward context’s clarity” scores than faculty participants in Context II.
Attitude toward context’s consistency
<i>Hypothesis 5.</i> Faculty participants in Context I will have higher “attitude toward context’s consistency” scores than faculty participants in Context II.
Attitude toward context’s constraints
<i>Hypothesis 6.</i> Faculty participants in Context I will have lower “attitude toward context’s constraints” scores than faculty participants in Context II.
Attitude toward context’s consequences
<i>Hypothesis 7.</i> Faculty participants in Context I will have lower “attitude toward context’s consequences” scores than faculty participants in Context II.

Table 10. Relationships between the independent variables and dependent variables in Context I.

Context I				
		Dependent variables: Self-efficacy in ...		
		1	2	3
Independent variables				
Attitude toward context's...		Planning	Adjusting	Reflecting
a	Clarity	Sig positive (HI-1a)	Sig positive (HI-2a)	Sig positive (HI-3a)
b	Consistency	Sig positive (HI-1b)	Sig positive (HI-2b)	Sig positive (HI-3b)
c	Constraints	Sig negative (HI-1c)	Sig negative (HI-2c)	Sig negative (HI-3c)
d	Consequences	Sig negative (HI-1d)	Sig negative (HI-2d)	Sig negative (HI-3d)

Table 11. Relationships between the independent variables and dependent variables in Context II.

Context II				
		Dependent variables: Self-efficacy in ...		
		1	2	3
Independent variables				
Attitude toward context's...		Planning	Adjusting	Reflecting
a	Clarity	Sig positive (HII-1a)	Sig positive (HII-2a)	Sig positive (HII-3a)
b	Consistency	Sig positive (HII-1b)	Sig positive (HII-2b)	Sig positive (HII-3b)
c	Constraints	Sig negative (HII-1c)	Sig negative (HII-2c)	Sig negative (HII-3c)
d	Consequences	Sig negative (HII-1d)	Sig negative (HII-2d)	Sig negative (HII-3d)

CHAPTER 3

METHODS

1. Mixed methods research design: Alignment with the purpose of study

The overarching purpose of this study is to enhance our understanding of the relationship between faculty *attitude toward the context* of curricular change and *self-efficacy in* and *willingness for* adaptability in that context. The two contexts in this study are Context I, characterized as being prescribed with interdependence during implementation (integrating the entrepreneurial mindset in the engineering curriculum), and Context II, characterized as being emergent with uncertainty during implementation (curricular change in response to the COVID-19 pandemic).

This study uses a mixed method, quantitative-qualitative, sequential explanatory research design to address the same problem (Morse, 1991). In this research design, the priority is placed on the quantitative phase of data collection and analysis (QUAN) followed by the qualitative phase of data collection and analysis (qual) to refine results from the quantitative phase (Creswell, 2008). Both phases are designed to meet the appropriate standard for quality if that research method stands alone. In the following sections, a clear articulation of the purpose of each phase is provided. The depiction of this research design can be visualized using the notation system proposed by Morse (1991) as:

QUAN → qual

1.1 Purpose of the quantitative phase of research

The purpose of the quantitative study is to understand faculty *perceptions* of self traits and *perceptions* of two different contexts of curricular change. More specifically, the purpose of the quantitative study is (1) to *compare* faculty *willingness for planning, adjusting and reflecting* in curricular change in two different contexts; (2) to *compare* faculty *self-efficacy in planning, adjusting and reflecting* in curricular change in the two different contexts. In addition, this study seeks (3) to *compare* faculty *attitude* toward the two different contexts. The research questions for the quantitative phase of the study are:

- Q1) How does faculty group in Context I differ from faculty group in Context II in terms of *willingness for* and *self-efficacy in planning, adjusting and reflecting* in each context?
- Q2) How does faculty group in Context I differ from faculty group in Context II in terms of *attitude towards each context*?

1.2 Purpose of the qualitative phase of research

The purpose of the qualitative study is to understand faculty *behavior* during curricular change. This is achieved by exploring faculty activities during curricular change in the two different contexts. The central phenomenon under this qualitative part of the study is faculty activities as they are shaped by external forces during curricular change. The exploratory nature comes from the inability to predict the external forces *a priori* in each context of the study, i.e., the enablers and barriers for *planning, adjusting and reflecting* during curricular change.

Q3) How do faculty respond to curricular change, as exhibited in their activities of planning, adjusting and reflecting during change?

Understanding differences in *perceptions* of self traits and contexts, in two different contexts of curricular change (quantitative phase), and understanding actual *behaviors* exhibited by faculty during curricular change (qualitative phase) **will contribute to our understanding of the important contextual factors that impact faculty behavior during curricular change and the way they influence faculty's behavior.** The findings from this research will highlight how faculty engage with efforts for changing the engineering curriculum. The ability of the individual faculty to respond to change has not been thoroughly addressed in the literature. Calls for change assume immediate adoption from faculty, overlooking their independent decision agency and their willingness to partner in enacting and evaluating change efforts. While change strategies consider various stakeholders, the central role that faculty play during the process remains generic and prescriptive without emphasis on the mechanisms of *how* faculty actually respond to calls for change.

2. Quantitative research method

2.1 Item generation and specific item features: First round

With the affective constructs used in this study, Figures 8 and 9, a minimum of five items per construct were developed to instantiate each construct, as recommended to specify the

latent constructs through relevant examples (Agresti, 2009). The minimum recommended number of items is used here to maintain a reasonable length of the instrument to be administered within the faculty population. To develop the items for this study, multiple approaches were used. First, the relevant literature was reviewed to situate the study in current understandings of the different facets of adaptability. Second, three different informal iterations with two faculty took place to gather information about the suitability of constructs as well as the representation of items within the constructs. Valuable feedback was gained from the experiences of colleagues, who came different roles and from different backgrounds in engineering. Finally, face and content validity were assessed as will be discussed in the next section.

Initial attempts to generating the items, and in order to instantiate the constructs, included using the following conceptual frameworks. Martin & Rubin (1994) cognitive flexibility scale (CFS) was used as a starting point. In their scale, cognitive flexibility is defined as a multidimensional construct, composed of three main components: (a) *awareness* that in any situation and context there are options and alternatives available; (b) *willingness* to be flexible and adapt to the situation; and (c) *self-efficacy* and confidence in one's ability to be flexible. The scale is a 12-item self-report measure; a higher total score indicates higher cognitive flexibility.

In addition, the strategic flexibility questionnaire (SFQ), developed by Cantwell & Moore (1996), was used as an inspiration in item development. The questionnaire is a 21-item self-report measure designed to assess one's self-regulatory control over learning. It consists of three subscales: (a) *adaptive control* (monitoring and planning items), (b) *inflexible*

control, and (c) *irresolute control*. Participants use a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree), to indicate their level of agreement with each item. The subscale with the highest score indicates one's control beliefs about learning.

Other sources of inspiration for item generation included Dweck's (2008) mindset survey, which consists of 27 items on a 5-point Likert scale. The study by Griffin, et al. (2007) was useful in developing performance adaptability items; however, because of its irrelevance to academic contexts it was difficult to map instances from that study. Items related to openness to change were initially modified from the study by Miller, Johnson & Grau (1994). The role breadth self-efficacy (RBSE) instrument, developed by Parker (1998), was used as an inspiration for items measuring perceived ability to carry out a broader and more active set of work roles. Items related to measuring the extent to which participants perceive of the support and encouragement they receive from their peers were inspired by the instrument developed by Anderson & West (1998) on team support and team climate. Items related to measuring organizational commitment were inspired by an instrument developed by Allen & Meyer (1990).

Since most of the items that instantiate performance adaptability and contexts come from organizational research, it was important to provide specific instances for the academic contexts of this study. The work by Lattuca & Stark (2009) was instrumental in mapping the different phases of adaptability and academic contexts to academic planning and curriculum development. In their framing, a curriculum is conceptualized as an academic plan with eight distinct features to be considered, which allows the identification of critical decision points (Lattuca & Stark, 2009). The items in the first round of the instrument development mapped

the phases of the adaptation to the relevant phases of academic planning. For example, an item related to *planning* in Context I was instantiated as follows: *During my efforts to integrate EM in my course, I was able to successfully identify appropriate learning objectives for this course.* Similarly, an item related to *willingness* in Context II was instantiated as follows: *Despite the forced change in teaching modality brought on by COVID-19, I was able to be open to implementing methods of instruction that are new to me.*

Demographics items

The list of demographics questions used in the instrument are listed in Table 12 . In order to ensure collecting sufficient demographics in the beginning of the instrument (for participants who may decide to leave the survey before completing all the items leaving missing data), questions about gender and ethnicity were viewed to participants in the beginning of the instrument, whereas questions about rank, years of teaching experience, discipline and institute were viewed toward the end. In the table, “Race/ethnicity” the provided options were based on the list required in NSF proposals. Also, the provided options on “Rank” were based on the most common ranks and as might be useful to interpret some of the findings about willingness to adapt. The categories of “Years of experience” were based on the work by Unal & Unal (2012) studying the impact of years of teaching experience on teachers’ classroom management approaches.

In Table 12 only potential demographics that could be used in the analysis, as well as other relevant information that were valuable to characterize the population, were used. The demographics that were of interest in the analysis were role, number of years of experience

and gender. Based on the literature, these variables could have an impact on an individual's willingness to adapt. For example, a Full Professor in a research-focused position may respond differently to questions about *planning* compared to a Lecturer in a teaching-focused position. Also, a faculty with more than 10 years of teaching experience may respond differently to questions about *reflecting* in Context II compared to a faculty with 0-5 years of experience. Demographics were also selected to be used to guide the selection of participants in the follow-up, qualitative phase of the study.

Table 12. List of demographics questions.

Please tell us more about you ...
Gender: <input type="checkbox"/> Male <input type="checkbox"/> Female <input type="checkbox"/> Prefer not to answer
Race/ethnicity: <input type="checkbox"/> Hispanic or Latino <input type="checkbox"/> American Indian or Alaska Native <input type="checkbox"/> Asian <input type="checkbox"/> Black or African American <input type="checkbox"/> Native Hawaiian or Other Pacific Islander <input type="checkbox"/> White
Rank: <input type="checkbox"/> Lecturer <input type="checkbox"/> Senior Lecturer <input type="checkbox"/> Assistant Professor <input type="checkbox"/> Associate Professor <input type="checkbox"/> Full Professor <input type="checkbox"/> Other; please specify _____
Number of years of teaching experience: <input type="checkbox"/> 0-5 years <input type="checkbox"/> 6-10 years <input type="checkbox"/> More than 10 years
Engineering discipline:
University:

2.2 Item validity: Second round

In order to assess *face validity*, items from the first round were presented to a sample of the target population (engineering faculty members), before administering the instrument, to assess the readability and understandability of items. For this purpose, three faculty members were recruited, who were teaching various engineering courses in different programs. All

evaluators described that the items were “straightforward and clear.” Notably, all members elaborated on the items in terms of what was missing and what should be included from their experiences teaching in the two contexts. Some of the feedback received included suggestions to include more questions on the *Planning* phase, as to whether class modifications had to be made “on the fly.” On the *Reflection* phase, comments were made to include items related to the quality of teaching, the attention to students’ feedback, and the missing human element of teaching in Context II. Suggestions also included adding more questions on the *Adjusting* phase of continuing to implement changes on the long run. Some suggestions included the need to inquire about faculty perception of uncertainty as the semester was wrapping up. Feedback on the procedural aspect of the survey included suggestions of not limiting the survey by asking participants to think of one course only, and to distinguish classes that required physical activities from others that were highly theoretical.

A major feedback that resulted in a significant modification in the second round was about the leading items’ stem and the need to ensure similarity between the stems of the instruments in the two contexts. More specifically, the previous leading statement in the instrument for Context II initially was “*Despite the forced change in teaching modality brought on by COVID-19 ...*” This was changed in Context II to be similar to become “*In changing my course due to the COVID-19 pandemic, I was able to .../I was willing to ...*” similar to the leading statement in Context I, “*In changing my course to integrate EM, I was able to .../I was willing to ...*”

In order to assess *content validity*, expert judgement was sought from the domain of relevance (engineering education research). Three experts were recruited who were different from the first reviewers. Experts were expected to have familiarity with the constructs and

frameworks. When communicating with the experts, the purpose of this study was not provided in order to provide an independent construct validity assessment. A major feedback in this area was around some discontinuity between the prompting for the respondents to consider (for example, “*During my efforts to integrate EM in my course, I was able to...*”) and some of the items themselves (for example, “*successfully identify appropriate learning objectives for this course*”). The concern was around whether the items who had this issue were referring to the complete course or just the parts in which EM were integrated. This valuable feedback prompted the need to refocus the instrument and the quantitative study to seek input on change of an entire course. There were multiple reasons for that.

First, after consulting with a KEEN Program Coordinator on one of the campuses that adopted the integration of EM early on, the insight provided was that different faculty achieve different levels of integration. Some were restricted to one assignment; others achieve full integration. So, it’s hard to make this delineation. As a concrete example to this issue, a feedback that was received from one faculty who taught in Context I was as follows:

“Personally, I find the entrepreneurial mindset term to be too ambiguous of a term as it encompasses a number of mindsets such as curiosity, while also getting at the idea of how we create value. You could argue all courses already teach EM to a certain extent. I personally try to design my course in a manner that fosters curiosity, creativity, motivation, and autonomy. I do this by having students work on an open-ended project. Students must navigate the design process to create a specific product that has a clear value proposition for a specific customer/stakeholder. Most of the instructors [of the same course] have students work on a specific design project where everyone creates the same thing (e.g. airplane, solar car, windmill, etc.).”

Therefore, it was not feasible to just focus on the EM integration aspect because the interpretation of the result will be inconsistent among participants. Instead, the decision was made to describe change for the entire course. Finally, it was intentional from the beginning

to make items in both instruments for Context I and Context II identical. Noting that change in Context II occurred *for the entire course*, not just aspects of it, it was more suitable to make the comparison with change over the entire courses across the two contexts.

Overall, while the difference is subtle, it is still important. However, what is also important (and as discussed in depth in the conceptual framework) is that change made by integrating new content into the course should have ramifications on the entire course (e.g., on the learning objectives). Because of the interest in studying adaptability, the impact of that change should be manifested in faculty's ability to adapt. There was still, however, a chance to tease out this slight difference in my follow-up interviews with faculty in the qualitative phase. Specifically, and as detailed in the following sections, the qualitative phase explored how is adaptation as a process exhibited in the activities of engineering faculty during curricular change? Therefore, the actual activities and behaviors of faculty during change can be captured in finer detail in that phase.

2.3 Measures

The developed and deployed instrument for this study measured *self-efficacy in* and *willingness for planning, adjusting and reflecting*. The original instrument also measured *attitude toward context* along the dimensions of context's *clarity, constraints, consistency* and *consequences*. Each of the measures asked on the instrument are shown in Table 13 through Table 15. After validity assessment, the instrument was modified to resulting in 5 items per construct. In the final instrument, a 5-Likert scale, ranging from "Strongly disagree" to "Strongly agree" was used

for ordinal measurement of the affective variables (Agresti, 2009) with moderate responses (McCoach, Gable, & Madura, 2013).

For the Context I instrument, the directions presented at the beginning of the survey provided a working definition for the EM based on KEEN's *Engineering Unleashed* website. The directions also asked participants that, when responding to items in the survey, to think about a course where they tried to integrate the EM in that course and when they taught that course prior to the COVID-19 pandemic, Figure 10. For the Context II instrument, the directions presented at the beginning of the survey asked participants to think about a course which they taught during the pandemic (Spring 2020 and beyond; the instrument was deployed at the end of Spring 2021).

Please note that, when talking about EM, we use the Kern Entrepreneurial Engineering Network (KEEN) website definition:

“An **entrepreneurial mindset (EM) is a collection of mental habits. These include an attentiveness toward opportunities and a focus on their impact, all with the intention of creating value. EM equips people to identify opportunities and create value in any context. This learned behavior is a way of thinking about the world and acting upon what you see.”**

(<https://engineeringunleashed.com/mindset>)

Remember ...

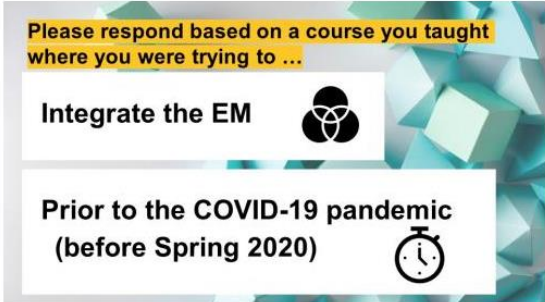


Figure 10. Directional instructions presented to participants in the beginning of the instrument survey in Context I.

Table 13. Final items used in collecting data about self-efficacy in planning (items 1-5), self-efficacy in adjusting (items 6-10) and self-efficacy in reflecting (items 11-15).

#	Item
	(For context I) In changing my course to integrate EM, I was able to ... (For context II) In changing my course due to the COVID-19 pandemic, I was able to ...
1	<i>allocate time</i> to modify plans as the semester was unfolding
2	identify which aspects of the course needed improvement
3	<i>dedicate time</i> to improve my future offering of this course
4	<i>inquire</i> about methods of instructions that influence students' learning
5	plan the course based on <i>the available course Learning Management Systems</i> (e.g., Blackboard, Canvas, etc.)
6	make <i>significant</i> changes
7	adjust the <i>course plan</i> as needed as the semester was unfolding
8	<i>implement</i> methods of instruction that were new to me
9	adjust the course "on the fly"
10	find help for adjusting the course
11	reflect on my effort to modify this course <i>during the semester</i>
12	informally evaluate my efforts with my students <i>during the semester</i>
13	review the impact of changes on the learning outcomes <i>at the end of the semester</i>
14	seek different ways to assess the students' achievement <i>at the end of the semester</i>
15	seek feedback on my teaching from my peers

Table 14. Final items used in collecting data about willingness for planning (items 1-5), willingness for adjusting (items 6-10) and willingness for reflecting (items 11-15).

#	Item
	(For context I) In changing my course to integrate EM, I was willing to ... (For context II) In changing my course due to the COVID-19 pandemic, I was willing to ...
1	<i>allocate time</i> to modify plans as the semester was unfolding
2	identify which aspects of the course needed improvement
3	<i>dedicate time</i> to improve my future offering of this course
4	<i>inquire</i> about methods of instructions that influence students' learning
5	plan the course based on <i>the available course Learning Management Systems</i> (e.g., Blackboard, Canvas, etc.)
6	make <i>significant</i> changes
7	adjust the <i>course plan</i> as needed as the semester was unfolding
8	<i>implement</i> methods of instruction that were new to me
9	adjust the course "on the fly"
10	find help for adjusting the course
11	reflect on my effort to modify this course <i>during the semester</i>
12	informally evaluate my efforts with my students <i>during the semester</i>
13	review the impact of changes on the learning outcomes <i>at the end of the semester</i>
14	seek different ways to assess the students' achievement <i>at the end of the semester</i>
15	seek feedback on my teaching from my peers

Table 15. Final items used in collecting data about attitude toward context’s clarity (items 1-5), consistency (items 6-10), constraints (items 11-15) and consequences (items 16-20).

#	Item
	(For context I) In changing my course to integrate EM, (prior to Spring 2020) ... (For context II) In changing my course due to the COVID-19 pandemic (in Spring 2020 and beyond), ...
1	I was able to find reliable sources of information when I needed them
2	I received well-developed information to help in changes I was making in the course
3	I considered my colleagues in my program to be aware of my efforts of change
4	I considered the impact of my efforts to be clear within the larger curriculum
5	I understood how much control I had over changing the course
6	I received compatible information <i>from various sources</i> on how to make changes in my course
7	I received compatible information <i>across time</i> on how to make changes in my course
8	The information I received from my university were consistent with the information I received from outside sources
9	I received support from my peers to continuously improve my course
10	I considered my efforts to change this course to be consistent with the overall program’s efforts
11	The implementation process was given to me so that it would be <u>strictly</u> followed
12	My implementation was closely monitored
13	My implementation was influenced by external factors (<i>e.g., societal needs</i>)
14	My colleagues in my program shared resources to help in the implementation of my plans
15	My implementation was influenced by internal factors (<i>e.g., department plans</i>)
16	my approach was motivated by a desire to generate positive learning outcomes for students
17	my approach was motivated by my perception of what my colleagues would think of me
18	my approach was motivated by what I thought the students evaluations would be
19	I was <u>looking forward</u> to implementing changes in this class
20	I was <u>anxious</u> about the overall consequences of changes in this course

2.4 Procedures: Participant recruitment

Participants were recruited via email correspondence (Appendix A-C). The email messages were very similar for participants in both contexts; the links used in the email messages directed participants to surveys of either Context I or Context II. After, the IRB protocol was approved (Appendix A), the list of potential participants who taught in both contexts started to be developed. Participation in this study was voluntary. Participation in the

quantitative phase involved completing one survey. The survey asked questions about experiences delivering courses in an engineering curriculum. Participants had the option to refuse to answer any question on the survey. This survey was designed to not take any longer than 10 minutes to complete.

One anticipated challenge was recruiting participants for Context I from faculty who were engaged in the KEEN program on participating campuses nationwide. While recruiting participants from Context II was not as challenging because the target population was significantly larger than that of Context I, the required number of participants from Context I that were needed to reach the required power was challenging to achieve. Initially, based on the list of faculty members who taught in that context in one university, the number was slightly above the required number. So, there was a risk to be mitigated there. One consideration was to contact faculty from the KEEN network who attempted similar efforts of integrating EM in their courses in other institutions. The instrument design had a placeholder to inquire about institution name in order to keep track of any potential variations in responses.

The approach was to reach out to programs in the KEEN network nationwide. The recruiting email was sent by email directly to the potential faculty participants. The email provided a brief about the study, a link to a consent form with directions on how to participate. There were two potential approaches to reaching out to faculty: either a contact person in the program would forward my request to the faculty, or the contact person will provide me with an email list of potential faculty participants to contact directly. However,

the best approach proved to be to acquire contact information for active faculty from the KEEN website and to reach out directly to them.

The proposed number of participants was based on an *a priori* power analysis of Power = 0.95. In social sciences, desirable power is > 0.80 (minimum total sample size for means comparison 128; that is 64 per context) and the typical power in the social sciences is 0.60. Conducting EFA requires a minimum of 100 participants (based on the rule of 5-10 participants per item kept in the revised instrument and depending on the emerged structure from EFA). The final, revised conceptual framework utilized three conceptualized factors for *self-efficacy*, three for *willingness*, and four conceptualized factors for *attitude toward context*. There were 5 items for each construct. It was expected that items for “attitude toward context’s *clarity*” and items for “attitude toward context’s *consistency*” may emerge under one category. While, based on the literature, these two were characterized as two separate factors, after careful analysis of the actual operationalization of the items as written and consulting with other faculty, these two categories may emerge as one category. The same applies for items for “attitude toward context’s *constraints*” and items for “attitude toward context’s *consequences*” which may also emerge under one category. Therefore, while contingency plans were provided, there were enough items to provide meaningful factors and that are loaded to meet the needed criteria.

2.5 Participants

The instrument was administered with the final 50 items for each context to a relevant sample of engineering faculty in each context recruited from higher education institutions

nationwide within the US. Data for the quantitative study were collected through an online survey using Qualtrics. To increase participation, follow-up emails and a tracking sheet were used (as discussed before). Participation was totally voluntary and no incentives were offered for participation. The distribution of the sample representation across the groups of this study is provided in Table 16. In Context I, 421 invitations were sent to faculty members in the KEEN network to participate; only 76 responded (response rate is 17.8%, 1 incomplete response). In Context II, 380 invitations were sent to faculty members who taught during the pandemic to participate; only 80 responded (response rate is 21.1%).

Table 16. Faculty participants distribution across the two contexts, based on gender, role-type, years of experience and race/ethnicity.

		C1: EM (75)	C2: COVID (80)
Gender	Male	51 (68%)	61 (76.3%)
	Female	22 (29.3%)	17 (21.3%)
	Other	2 (2.7%)	2 (2.5%)
Role-type	Group A	35 (46.7%)	18 (22.5%)
	Group B	40 (53.3%)	62 (77.5%)
Years of teaching experience	0 - 5 years	21 (28.0%)	28 (35.0%)
	6 - 10 years	16 (21.3%)	13 (16.3%)
	> 10 years	38 (50.7%)	39 (48.8%)
Race/ethnicity	Hispanic or Latino	6 (8.0%)	3 (3.8%)
	American Indian or Alaska Native	0	0
	Asian	11 (14.7%)	19 (23.8%)
	Black or African American	2 (2.7%)	2 (2.5%)
	White	58 (77.3%)	52 (65.0%)
	No response	3 (4.0%)	6 (7.5%)

^a Group A: Self-identified as “lecturers, senior lecturers, or adjunct”

Group B: Self-identified as “assistant, associate, or full professor”

2.6 Analytical procedures

No missing data was used in the exploratory factor analyses for all constructs, resulting in a sample of 75 participants from Context I and 80 participants from Context II. Given the resulted collected sample size, it was recommended to proceed with the analysis. The analysis involved exploring correlations, conducting exploratory factor analysis (EFA), and assessing internal consistency reliability. The detailed steps are provided below. For the internal consistency reliability, the measure addressed the variation in individual responses within the set of items measuring a construct, based on a single administration of the instrument to a single group of respondents. It is most commonly evaluated using Cronbach's coefficient alpha (Agresti, 2009).

The correlation tables were examined and evidence was found for inter-item correlations between items that should correlate. An EFA using principal axis factoring was used. As expected and conceptualized, each construct (each containing 5 items) was examined separately and found to load under one factor only; therefore, rotations were not necessary to optimize the loading. For example, *self-efficacy in planning* resulted in one factor only, and the same for all other constructs.

In the first round of analysis, for each construct, in each context, Bartlett's value $p = 0.000 < 0.05$ was achieved, Table 17. In the same table KMO-test are provided with (>0.6 and >0.8 resulted, indicating data set is suitable for factor analysis (Agresti, 2009). Based on the scree plots and Kaiser's criterion with eigenvalues > 1.0 , one factor for each constructed was achieved and explored for factor loading. Based on high factor loadings on one item (>0.4) and low loading (<0.3) on all other factors, the items shown in Table 18 were

retained. Note that, in Table 18, items for attitude toward context’s *clarity* and *consistency* were found to load together for a high Cronbach’s coefficient alpha and across contexts. This was expected as discussed previously under the section on “Procedures.” Also, items for the attitude toward context’s *consequences* were found not to be factorable and therefore they were not included for further analysis. One reason for that is perhaps the inconsistency of interpretation by participants of the intent of the items across contexts.

Table 17. First round analysis to check for suitability of data for factor analysis, for each construct in each context. ^a

	Affective domain	Context	Bartlett's test ($p < 0.05$)	KMO (>0.6, >0.8)	Number of factors extracted
Planning	SE	C1	0.000	0.752	1
		C2	0.000	0.738	1
	W	C1	0.000	0.822	1
		C2	0.000	0.739	1
Adjusting	SE	C1	0.000	0.698	1
		C2	0.000	0.763	1
	W	C1	0.000	0.836	1
		C2	0.000	0.816	1
Reflecting	SE	C1	0.000	0.661	1
		C2	0.000	0.691	1
	W	C1	0.000	0.811	1
		C2	0.000	0.740	1
Clarity and consistency	ATT	C1	0.000	0.778	1
		C2	0.000	0.802	1
Constraints	ATT	C1	0.000	0.647	1
		C2	0.000	0.726	1
Consequences	ATT	C1	Not factorable		
		C2	Not factorable		

^a SE = *self-efficacy*; W = *willingness*; ATT = *attitude*; C1 = EM context; C2 = COVID context.

2.7 Exploratory Factor Analysis (EFA) results

After removing underperforming items from each construct in each context, the resulting items were examined. While items in each context, generally, grouped together for the two contexts, that was not always the case, as shown in Table 18 through Table 20. However, there is no conclusive statement that can be made as to why this has been the case, given that for the most part, items grouped together similarly across the two contexts.

An additional EFA was performed with the remaining items (with all other items removed) where one factor was explored for each construct, and was found to be factorable with one resulting factor (Bartlett's value $p = 0.000 < 0.05$. KMO-test > 0.6). The final structure was explored for internal consistency; the Cronbach's alpha values for each construct are included in Table 18 through Table 20. With values of alpha higher than 0.70, the items show internal consistency, indicating the accuracy with which an instrument measured the intended factors. Based on the final, established factor structure, item responses for each factor were grouped together, summed and scaled out of 10 for the analysis. As mentioned before, the factors in their final extraction match the theoretical constructs of *self-efficacy in* and *willingness for planning, adjusting and reflecting*, as well as *attitude toward context's clarity and constraints*.

Table 18. Factor loading for final items retained for analysis after the EFA for the self-efficacy in planning (items 1-5), self-efficacy in adjusting (items 6-10) and self-efficacy in reflecting (items 11-15) constructs.

#	Item	Factor loading in CI	α in C1	Factor loading in CII	α in CII
(For context I) In changing my course to integrate EM, I was able to ... (For context II) In changing my course due to the COVID-19 pandemic, I was able to ...					
1	<i>allocate time</i> to modify plans as the semester was unfolding	0.629	0.711	0.705	0.799
2	identify which aspects of the course needed improvement	0.649		0.816	
3	<i>dedicate time</i> to improve my future offering of this course	0.648		0.684	
4	<i>inquire</i> about methods of instructions that influence students' learning	0.564		0.622	
5	plan the course based on <i>the available course Learning Management Systems</i> (e.g., Blackboard, Canvas, etc.)	Not included		0.525	
6	make <i>significant</i> changes	0.486	0.733	0.697	0.771
7	adjust the <i>course plan</i> as needed as the semester was unfolding	0.838		0.702	
8	<i>implement</i> methods of instruction that were new to me	Not included		0.643	
9	adjust the course "on the fly"	0.637		0.775	
10	find help for adjusting the course	0.649		0.427	
11	reflect on my effort to modify this course <i>during the semester</i>	0.619	0.721	0.505	0.703
12	informally evaluate my efforts with my students <i>during the semester</i>	0.542		0.572	
13	review the impact of changes on the learning outcomes <i>at the end of the semester</i>	0.495		0.684	
14	seek different ways to assess the students' achievement <i>at the end of the semester</i>	0.753		Not included	
15	seek feedback on my teaching from my peers	0.543		0.683	

Table 19. Factor loading for final items retained for analysis after the EFA for the willingness for planning (items 1-5), willingness for adjusting (items 6-10) and willingness for reflecting (items 11-15) constructs.

#	Item	Factor loading in CI	α in CI	Factor loading in CII	α in CII
(For context I) In changing my course to integrate EM, I was willing to ... (For context II) In changing my course due to the COVID-19 pandemic, I was willing to ...					
1	<i>allocate time</i> to modify plans as the semester was unfolding	0.720	0.822	0.728	0.853
2	identify which aspects of the course needed improvement	0.936		0.785	
3	<i>dedicate time</i> to improve my future offering of this course	0.824		0.836	
4	<i>inquire</i> about methods of instructions that influence students' learning	0.797		0.833	
5	plan the course based on <i>the available course Learning Management Systems</i> (e.g., Blackboard, Canvas, etc.)	0.423		0.572	
6	make <i>significant</i> changes	0.768	0.867	0.721	0.832
7	adjust the <i>course plan</i> as needed as the semester was unfolding	0.888		0.832	
8	<i>implement</i> methods of instruction that were new to me	0.905		0.679	
9	adjust the course "on the fly"	0.621		0.751	
10	find help for adjusting the course	0.628		Not included	
11	reflect on my effort to modify this course <i>during the semester</i>	0.871	0.894	0.617	0.815
12	informally evaluate my efforts with my students <i>during the semester</i>	0.819		0.806	
13	review the impact of changes on the learning outcomes <i>at the end of the semester</i>	0.819		0.812	
14	seek different ways to assess the students' achievement <i>at the end of the semester</i>	0.845		0.652	
15	seek feedback on my teaching from my peers	0.648		0.583	

Table 20. Factor loading for final items retained for analysis after the EFA for the attitude toward context's clarity (items 1-10) and constraints (items 11-15).

#	Item	Factor loading in CI	α in CI	Factor loading in CII	α in CII
(For context I) In changing my course to integrate EM, (prior to Spring 2020) ... (For context II) In changing my course due to the COVID-19 pandemic (in Spring 2020 and beyond), ...					
1	I was able to find reliable sources of information when I needed them	0.641	0.824	0.699	0.882
2	I received well-developed information to help in changes I was making in the course	0.723		0.687	
3	I considered my colleagues in my program to be aware of my efforts of change	0.448		0.670	
4	I considered the impact of my efforts to be clear within the larger curriculum	0.410		0.636	
5	I understood how much control I had over changing the course	Not included		0.527	
6	I received compatible information <i>from various sources</i> on how to make changes in my course	0.759		0.712	
7	I received compatible information <i>across time</i> on how to make changes in my course	0.742		0.697	
8	The information I received from my university were consistent with the information I received from outside sources	0.580		0.737	
9	I received support from my peers to continuously improve my course	0.517		0.593	
10	I considered my efforts to change this course to be consistent with the overall program's efforts	0.510		0.555	
11	The implementation process was given to me so that it would be <u>strictly</u> followed	0.728	0.719	0.836	0.847
12	My implementation was closely monitored	0.883		0.845	
13	My implementation was influenced by external factors (<i>e.g., societal needs</i>)	0.494		0.537	
14	My colleagues in my program shared resources to help in the implementation of my plans	0.408		0.713	
15	My implementation was influenced by internal factors (<i>e.g., department plans</i>)	Not included		0.698	

3. Qualitative research method

The purpose of the qualitative study is to *explore* the process of adaptation during curricular change for engineering faculty in the two different contexts. The central qualitative research question is: *How do faculty respond to curricular change, as exhibited in their activities of planning, adjusting and reflecting during change?* In this section, the rationale for a qualitative phase in an explanatory mixed method research design is provided, followed by data collection and analysis methods. Validity issues are discussed at the end of the section.

3.1 Rationale for the qualitative phase: Explanatory mixed method research design

The inclusion of this phase assumes that the emergence of differences in findings between the two contexts of this study, or, alternatively, the rejection of proposed hypotheses, may reflect a complex combination of interactions between factors that are not captured by the quantitative study alone. Furthermore, the inclusion of *actual* evidence of response to change, in combination with the *self-reported* survey results, will allow richer explanation for the *process* of adaptation of faculty during curricular change. This research integrates analysis from quantitative and qualitative data. In mixed method research, it is customary to divide the reported work into two “methods and results sections” for each phase, and a single “discussion” section that synthesizes the two sets of findings (Creswell, 2008).

In explanatory mixed method research design, data is collected sequentially, with the first phase informing the second phase (Ivankova, Creswell, & Stick, 2006). This research design is also called the “two-phase model” (Creswell, & Plano Clark, 2007) and is used so that the subsequent qualitative phase will “help explain or elaborate on the quantitative

results” (Creswell, 2008, p. 560). In this study, the emphasis is placed on the proceeding quantitative study in terms of both *priority* (or *weight*) and *sequence*. In term of priority, the quantitative study represents the major aspect of data collection because there exists a need to understand the relationship between faculty *attitude toward context* with *self-efficacy in* and *willingness for* in adaptability in that context. The findings will characterize this relationship quantitatively, adding to our understanding of this gap in the literature. In terms of sequence, the qualitative data will be collected to *explain* the quantitative results.

Paths for explanation afforded by the qualitative phase

Conducting the qualitative analysis will help in understanding how the adaptation process is exhibited during curricular change in terms of faculty behaviors and activities. There are three possible paths for explanation that the follow-up qualitative phase may offer. First, outlier or extreme data may emerge from the quantitative study. In this case, qualitative data can be collected from these cases to explore their characteristics (Caracelli & Greene, 1993). Second, while the quantitative analysis may result in identifying differences between faculty participants from the two contexts, the follow-up qualitative phase may help explaining *why* there is a difference. For example, after the correlational analysis between variables (i.e., *attitude toward context* and *self-efficacy in* adaptability), an in-depth corresponding narrative may help in exploring why there are differences between the two contexts (e.g., Blustein et al., 1997). It could be that findings from the first quantitative phase are contradictory, requiring the in-depth explanation. As an illustration, it could be that no significant difference in attitude is found between the two different contexts when, in fact, a significant difference in

adaptability is reported. In a study of seventh- and eighth-grade science students, Houtz (1995) found contradictory results of attitude and achievement, which prompted her for a follow-up qualitative study with teachers and administrators. A third possibility of explanation is using the typology of the resulted factor structure from the quantitative phase to identify themes in the qualitative data (Caracelli & Greene, 1993).

Matching quantitative data analysis with qualitative research design

Although using a mixed method approach implies collecting both quantitative and qualitative data, the real benefit of using a mixed method is more than simply finding links of interest between data from the two phases of the study. It is of interest, as explained before, to understand how adaptation is reflected *as a process* on the behaviors and activities of faculty during curricular change. Beyond just mixing the findings, the results from the quantitative analysis should *inform* the qualitative phase (Morse, 1991; Tashakkori & Teddlie, 1998). During data collection, the inquiry evolved as quantitative responses were collected from participants, guiding the interview protocol in the follow-up study. While the *research question* of the qualitative phase remained of interest, as findings from the quantitative analysis emerged, the *interview questions* during data collection evolved as well. As proposed in the central research question, of particular interest will be the exploration of any differences between *reported* attitude, self-efficacy and willingness measures (in the quantitative study) and *actual* process and outcome of change (in the qualitative study). The identified options for *explanation* (as described before) will help in ensuring the matching between data analysis and design of this mixed method approach.

Advantages and disadvantages of explanatory mixed method research design

Overall, the explanatory mixed method research design benefits from the advantages of both the quantitative approach (by obtaining results from a large population) and the qualitative approach (by offering deeper insights into findings through elaboration and explanation). Moreover, the research does not have to converge in order to integrate results—a requirement in triangulation mixed methods designs (Creswell, 2008). One difficulty in this approach is that the researcher has to deliberately determine which aspects of the quantitative analysis need to be explained in-depth in the follow-up phase (Ivankova, Creswell, & Stick, 2006). The research design has been also described as labor intensive requiring expertise in both quantitative and qualitative research methods (Creswell, 2008; Tashakkori & Teddlie, 1998).

3.2 Qualitative research design

In qualitative research, a researcher analyzes qualitative data in search for meaning or to understand a central phenomenon (Creswell, 2008). The results of qualitative research are reported in terms of central tendencies (Patton, 2014). Qualitative research has the quality of flexible modification during the study in response to new, emerged understanding; i.e., “reflexivity” (Robson, 2011). In the qualitative phase of this study, grounded theory is selected as a qualitative research method because it allows the collection of open-ended responses from interviews, which provides the needed richness for substantiate explanation in this phase of the study (Saldaña, 2013). Moreover, qualitative research enables capturing the experiences of participants (Glesne, 2016; Patton, 2014) and thus allowing an

opportunity to understand how various external forces of the different contexts of this study shaped their adaptation processes.

Grounded theory as a form of inquiry: Advantages and disadvantages

A grounded theory design is suitable for this study because the interest is in exploring “experiences of individuals” to develop an understanding of adaptation processes (Creswell, 2008, p. 60). Developed in the 1960s by sociologists Glaser and Strauss, grounded theory uses a systematic set of procedures to develop an understanding of interactions within a social phenomenon (Glaser & Strauss, 1967). A grounded theory approach is associated with research that examines a number of individuals who all have experienced “an action, interaction, or process” (Creswell, 2008, p. 61). Compared to the quantitative phase where data were collected from a large sample in the population, grounded theory generates a general explanation that is grounded in data from participants who are carefully selected through theoretical sampling (Glaser & Strauss, 1967).

An advantage of grounded theory is that it incorporates a process approach that is both systematic and emergent. Although the central idea under study is around adaptation during curricular change as experienced by faculty participants in two different contexts, a grounded theory approach allows examining the experiences as a process taking place holistically in a social world (Strauss & Corbin, 1998). Theoretical sampling in grounded theory is purposeful in that it seeks participants who will enable the explanatory nature of this phase of the research. By allowing the researcher to stay close to and “grounded” in the

data, this research method provides substantial evidence answering a research question related to experiences and processes.

Some of the disadvantages of this research method is that, because it followed the quantitative phase, potential candidates had to be recruited who would provide valuable insights to this study; however, the timeline of the research design could not be precisely determined as the quantitative data continued to be collected (Creswell, 2008). Furthermore, given the level of commitment of the participants in this study (i.e., faculty) it was difficult to find suitable time to engage in a reflective interview. Because the process of meaning making during the analysis focused on explaining the quantitative results, it was challenging to not miss some of the more nuanced data (Patton, 2014), to avoid providing incomplete explanations (Robrecht, 1995) which may lack conceptual depth (Becker, 1993). Finally, and as will be discussed later, limitations include the inherent subjectivity in the entire process of this qualitative research design (Walther, Sochacka, & Kellam, 2013; Peshkin, 1993).

3.3 Qualitative data collection

Artifact elicitation as a data collection method

Data can be collected in many forms in grounded theory. Interviewing is very common in grounded theory, especially to capture the experiences of participants using their own words (Charmaz, 2000; Creswell, 2008). In this study, *artifact elicitation* was used as a data collection method. In this method, faculty as participants were asked to bring an artifact of their own choice to the interview. The artifact should manifest what the faculty conceive of as an effort to modify their course in response to change in the curriculum. Each interview started by

asking participants to describe what they brought with them. Afterwards, the interview moved to ask the participant about other experiences of curricular change, allowing the elicitation of adaptation behaviors and activities during the interview. The collected data were in the form of recorded interviews (Zoom sessions) which were then transcribed for analysis.

As a data collection method, artifact elicitation is a derivative of the photo elicitation method, where participants are typically asked to bring a photo to an interview (Clark-Ibanez, 2004; Harper, 2002; Harrison, 2002; Prosser & Schwartz, 1998). The photo enables the participant to physically point to visual cues in it, which can lead to larger discussions related to the research study (Pink, 2001; Stanczak, 2007). According to Copeland & Agosto (2012), “visual data representing personal understandings of concepts, experiences, beliefs, or behaviors, can be especially useful in helping participants to express complex or abstract ideas or opinions” (p. 513). This method facilitates the critical reflection because it has the “power to capture unfettered visual conceptions of information, especially personal, pleasurable, and profound dimensions, which are increasingly relevant” (Hartel, 2014, p. 1350). Artifact elicitation as a method has been used to study Makers (Jordan & Lande, 2015; Lande & Jordan, 2017).

While artifact elicitation offers the advantage of providing descriptions about faculty’s behaviors and contextual factors, it also has some disadvantages. As reported by Douglas et. al. (2015), some disadvantages include: the difficulty of coordinating an interview time when it is convenient for a participant to bring the artifact. Also, there is the challenge of attending to multiple things during the interview, such as the interview protocol and the

recording, while being simultaneously engaged with the participant and following up with important questions when needed. Furthermore, there is the need for being mindful that participants may become enthused about their artifact and less reflective in the responses they provide. In order to mitigate some of these shortcomings, the interview protocol was semi-structured so that it moved from the specifics of the artifact at hand, to other contexts such as previous attempts to adjust a course, and, correspondingly, to more general aspects of adaptation as a process in curricular change, as well as enablers and barriers for adaptation.

Interview protocol development

The interviews were the primary source of data for the qualitative phase. The interviews were developed to enable reflection by following a semi-structured protocol that encouraged asking follow-up questions where a participant seemed to need to expand upon a given response. The same interview protocol was used for all participants, with slightly different follow-up questions depending on the description of the artifact that each faculty provided and the faculty member's responses and experiences. Interviews lasted for between 30 minutes to more than an hour.

The interview protocol is provided in Appendix H. The interview protocol was structured around the three major phases of adaptation and as conceptualized in the framework for this study: *planning*, *adjusting* and *reflecting*. The grand tour questions during the interviews will be as follows:

- What did you bring with you? [Tell me more.]

- Did you *plan* for this (activity)? How?
- How did this (activity) go?
- Do you consider the *change* you introduced in your class by this (activity) as *significant*? How? [Or why or why not?]
- Do you consider this activity to be a representation of *your adaptability* for change as a faculty member? Why or why not?
- Is there anything else you'd like to add?

In developing the protocol, the questions were informed by (1) the literature on the topic, in addition to (2) the emerged themes from the quantitative phase in order to offer the needed explanation. As for the literature on the topic, and as discussed in Chapter 2, it influenced the need to ask about the thoroughness of planning that went in delivering the intervention made by the faculty participant, the significance of change in relation to the curriculum as viewed by the faculty participant, and the dedication for reflecting on outcome of change as characterized by the faculty participant. A significant starting point for developing the interview protocol was the interview protocols developed for the Pedagogical Ninjas Program as part of the NSF-funded *Revolutionizing Engineering and Computer Science Departments* at Arizona State University, which I helped develop and iterate on (see Ali, Abhyankar, Brunhaver, Bekki, & Jordan, 2020). The questions, as part of that study, proved to allow deep reflections by faculty participants who engaged in curricular change effort, and, therefore, were a suitable starting point. At the same time, and as to the emerged themes from the quantitative phase, the follow-up questions attempted to elicit more about the context (e.g., “Tell me about the EM integration efforts on your campus”) or the faculty role-type differences (e.g., “Has the research expectations in the way you taught during COVID?”). Overall, in developing the interview protocol, an emphasis has been made on

understanding the enablers as well as the barriers for faculty's behavior in each phase of adaptation.

Before conducting the interviews, participants were asked to sign a consent form (Appendix G) approved by the Institutional Review Board (IRB). In order to save time during the Zoom interview and in order to allow participants to get familiar with the purpose of the study, the consent forms were sent electronically in advance. I found this step to be important, especially to build trust early on in a virtually conducted interviews, where a significant number of participants were faculty members whom I have not met before.

The interviews were recorded via Zoom, and the transcriptions afforded by Zoom were checked for accuracy. After transcription, interviews were anonymized by giving faculty pseudonyms and hiding any references to courses they mentioned, references to their institutions or anything it was believed would expose their identities. Interviews were then shared with faculty participants for verification and approval. In few occasions, clarification and additions were requested as a way for confirming representation (Creswell, 2008). Generally, data collection for this qualitative phase sought rich descriptions, as demanded by a grounded theory approach, in order to help the readers decide about the transferability of findings.

Participant selection

The process of data collection started with theoretical sampling by intentionally selecting faculty participants who could contribute to the explanatory purpose of this phase. Because this phase followed a previous data collection from the quantitative phase, data could be

collected as a whole and then analyzed. In pure qualitative studies, Creswell (1998) recommends collecting data from at least 20 to 30 participants as a general guideline to start developing categories. Because of the explanatory nature of this phase, in a mixed method research design, and in order to provide in-depth narratives that explain the findings from the previous phase, a total number of 14 participants was used as a target; 7 from each context in this study.

Participant recruitment

Recruiting participants for the qualitative phase for Context I of the study involved identifying faculty members from the KEEN network who were particularly active in the program on their campus and who were willing to share their experiences. In some cases, a snowball participant recruiting strategy was used where one participant helped in identifying another participant. The initial email for recruitment (see Appendix E) had the subject line “*Asking to meet with you to share your experience integrating the Entrepreneurial Mindset*” and included language asking for help in data collection, sharing experience, and the unique perspective a faculty member can bring. I learned from data collection efforts from the quantitative phase that asking faculty members to volunteer time and participate in a research study can be extremely challenging; however, overall faculty member can be very generous when asked for help, as this seems to be the natural requirement of their profession in education. If no response was received from the first email, a follow-up email was sent, often promoting a response in the second time. Compared to data collection in the quantitative phase, where an attention-getting email with graphics was used, here a more personalized and professionally

structured email was used. A tracking sheet was used to track responses from potential participants, with more than two emails were sent for each faculty members. I found that sending more than two emails to each potential participant to be both discouraging and slandering, especially in the academic community.

A similar approach of recruiting participants for Context II was used (Appendix B). Compared to recruiting participants who were involved in integrating the EM, recruiting participants who taught during the COVID pandemic was more achievable, especially that all faculty members (except for a few who did not teach during the pandemic) were affected by the pandemic. There were a few who refused to participate and gave the reason that they already provided multiple feedback on the topic to various sources during the past months. Overall, choosing a suitable time that meets faculty commitments was important. I was trying to avoid rush time (e.g., end-of-semester, exam- and project-times) when faculty were busy, and found that the time after the end of the semester to be very suitable as a reflective period for faculty who were open to share their experiences when memories of the sequence of events were fresh in their minds. The list of faculty participants' pseudonyms, teaching domains, years of teaching experience and the artifacts they brought to the interviews are listed in Table 21.

Table 21. List of participants of the qualitative study.

Participant (pseudonym)/ (Gender)	Context	Role	Teaching domain	Years of teaching experience	Shared artifact¹
Alex (M)	C1	Teaching in R1	Biomedical	> 10 years	Observations and interviewing in medical context
Brooke (F)	C1	Research	First-year	> 10 years	Scaffolded workbook and activities
Connor (O)	C1	Teaching	Civil	5 - 10 years	Integrating social context in a statics class
Griffin (M)	C2	Research	Capstone, general engineering	> 10 years	Online delivery of industry partners showcase
Jack (M)	C1	Teaching in R1	Mechanical	> 10 years	Need finding in capstone design
Kaleb (M)	C1	Teaching	Design	5-10 years	Sprint project cycles
Mary (F)	C1 + C2	Teaching in R2	Communication in engineering	> 10 years	Contextualizing a circuits class
Miles (M)	C1 + C2	Teaching	Electrical	5 - 10 years	Use of case studies
Robert (M)	C1	Teaching	Materials	5 - 10 years	E-portfolios
Sophie (F)	C2	Teaching in R1	First-year	0 - 5 years	Sending project kits to students at home
Tanner (M)	C2	Teaching in R1	Mechanical	> 10 years	Recorded lectures and Zoom delivery
Vagish (M)	C2	Research	Multimedia	0 - 5 years	Recorded lectures and outdoor class activities
Vera (F)	C1 + C2	Research	Environmental	> 10 years	Student-defined lab sessions
Xavier (M)	C1 + C2	Research	Mechanical and civil	5 - 10 years	Combining research activities and design in an economy class

¹ Often times, faculty brought actual artifacts to the interviews. Other times, they described it and shared actual documents after the interview. Some other times, they just provided rich descriptions of examples of their implementations.

Often times, participants recruited from the EM-context were naturally talking about the COVID-context, which is understandable given the intertwining between the two contexts during the time I was conducting the interviews. I tried to maintain a balance between allowing this natural transition and staying the course with my interview protocol, mainly because when collecting the quantitative data a specific request was given to provide responses based on integrating the EM before the pandemic (before Spring 2020). At the same time, the insights provided by the EM-context participants about teaching in the COVID-context were valuable in providing explanations from faculty adaptability. In recruiting participants for interviews in the COVID-context, the majority were participants who also participated in the quantitative phase. Particularly, participants who completed their responses to the instrument, provided written, optional responses, and indicated their interest and availability for a follow-up interview, were recruited.

As discussed before, in this mixed research design, quantitative data collection and preliminary analysis preceded the qualitative data collection, allowing for the evolution of the interview protocol. More specifically, as preliminary quantitative analysis indicated the potential difference between teaching- and research-focused faculty members within each context, participants from these subgroups were particularly recruited from each context in order to provide rich explanations. Additionally, interview protocol questions, as well as follow up questions, were developed to provide more explanations.

2.5 Qualitative data analysis

Data analysis started with an open approach to one of the three potential explanation paths described before, under “*Paths for explanation afforded by the qualitative phase*” One path was to focus on the outliers or extreme data to explain their characteristics. A second path was to focus the analysis on explaining *why* there was a difference between participants from each context. A third path was using the resulted factor structure from the quantitative phase to identify themes in the qualitative data. A combination of the second and third path were used in the qualitative data analysis. In general, in grounded theory, data analysis starts by generating initial categories through *open coding*, connecting categories through *axial coding*, and developing the theory through *selective coding* (Glaser & Strauss, 1967). Open coding involves naming and categorization of data as transcripts are reviewed and data with similar properties are grouped together, with a recommended number of 10 categories as a beginning (Creswell, 2008). The process aims to capturing concepts that make up experiences (Geertz, 1974). It is expected that codes will capture behaviors and activities as well as enablers and barriers for faculty participants in different adaptation phases.

Data analysis was achieved by constant comparison which was an inductive process that compared gathered data with new one (Glaser & Strauss, 1967), allowing categories to emerge until saturation was reached, which was the state reached when new data did not provide new insights. Sustained engagement with the data allowed categories to emerge, through gradual abstraction and use of *in-vivo* codes (Richards, 2005). After saturation was reached, core categories were identified as the basis for forming the needed explanation, as these categories could “process out” adaptation; that is, the experience under study (Glaser,

1978). According to Strauss & Corbin (1998), a core category is one that is central, frequently appearing in the data and provides an explanation that relates to other categories without being forced. The identified core categories in this step were aligned with the phases of adaptability based on the conceptual framework for this study. These core categories followed naturally from the way the interview protocol was structured in order to *explain* the quantitative findings in this mixed method research design. The core categories were as follows:

- *Self-efficacy in planning*
- *Willingness for planning*
- *Self-efficacy in adjusting*
- *Willingness for adjusting*
- *Self-efficacy in reflecting*
- *Willingness for reflecting*

Selecting the core category enabled axial coding where “causal conditions, intervening and contextual categories, strategies, and consequences” were identified (Creswell, 2008, p. 450) to generate an understanding of the external forces in each context that influenced adaptation. The process aimed to moving to higher levels of abstraction, with visuals usually used to illustrate interactions (Strauss & Corbin, 1998). Axial coding in grounded theory is followed by generating theoretical propositions in a systematic manner (Strauss & Corbin, 1998), that uses selective coding to interrelate categories, providing testable ideas to generate the theory (Creswell, 2008). In the interpretation process, the aim “is not to reduce complexity by breaking it down into variables but rather to increase complexity by including context” (Flick, 2006, p. 98).

2.6 Analytical procedures

Because the purpose of the qualitative study is to explore *the process* of adaptation during curricular change, *process coding* was used to code action in the data: observable activities (such as, *planning*), especially in the early phases of detailed coding of data. Consider, for example, the coding of this note from Vera:

“I think in both of those cases ... they're both two different KEEN workshops. And so, most of the **thinking** about what am I going to do and how am I going to do it actually took place in the workshop” [*Forming intention*]

Process coding uses gerunds (“-ing” words) to connote actions. Actions are intertwined with time, and are embedded in psychological beliefs (Saldaña, 2013). Process coding aims at capturing sequences of actions and reactions. Therefore, a process ideally has delineated phases which can be observed in the use of phrases such as *if, when, then, because, so, etc.* Dey (1993) suggests that process coding can be used to “obtain a sense of how events originate and evolve, and their shifting significance for those involved” (p. 38).

For example, note the evolving of this action-reaction in Griffin’s description of how he reacted to the pandemic:

“**[Okay, well, so the first real impact that the pandemic had on us was in January. We were doing our planning for the forum again, which is where the companies come together and present what they want the students to do. And it was a face-to-face event, and the day of the event, one of the company's called us and said they weren't coming because of the pandemic.]**_{Action} → [And at the time we thought they're crazy; you guys are just way overreacting here.]_{Reaction} **[And so we went ahead; we assigned projects. In the first capstone, groups were working on their projects.]**_{Actio} → [And then we watched ... we sort of watched the pandemic news like everybody did, but I don't think we necessarily expected it to affect what we were doing very much.]_{Reaction} **[And so we didn't really have any contingency plans worked out. And then during spring break, which I think was about March, around March 15th, we got an email from the**

administration, saying that everything was going virtual. And it was actually kind of interesting.]_{Action} → [Basically everything I was involved in, you know, from a personal perspective, also from work, went virtual that week. And all of a sudden, I'm going, "Wow, I guess I better pay attention here.]"_{Reaction}

In Griffin's example, process coding may involve coding actions and coding sub-actions:

- Planning
 - Setting goals
 - Interacting with context
- Making
- Reflecting
 - Observing
- Adjusting
 - Controlling anxiety

In addition to process coding, *concept coding* was used as an analytical procedure.

Concept coding uses abstract ideas as concepts. Nouns can be used, but verbs and combinations of nouns and verbs can be better options to move from coding small, observable actions to coding concepts (Saldaña, 2016). Concept coding uses larger constituents, represented in larger chunks of data, with the goal of theory building, which in turn is motivated by more generalizable abstract contexts. Because of the interest in *explaining* the quantitative findings, concept coding was used in the later stages of the analysis, especially when analyzing transcripts by speaker-turn.

Codes in concept coding should stimulate reflecting on larger social constructs. The process overlaps with process coding in that it's conceptual in nature, but it can also use *in-vivo* coding. To identify concepts in the data, Saldaña (2016) recommends observing shifts in the topics that a participant discusses which suggests a new concept. For example, in

Griffin's example, he shifts from talking about personal activities, to describing the context, to talking back again about personal reactions.

Concept codes are highly interpretive and requires a creative stance. Creative phrases allow richer meanings; however, with knowledge about the research question and purpose, adequate alignment can be used in creating the phrases. The complete code book for analysis is provided in Appendix I.

Practical considerations during analytical coding

The two methods used in the analysis are the same in being "elemental methods" in that they have "basic but focused filters" for reviewing the data and building foundations for next cycles of coding (Saldaña, 2013, p. 83). In addition, as illustrated in multiple locations, the methods overlap in their use: both process and concept coding, for example, share the virtue of both being conceptual and tend to move to higher levels of abstraction. The two methods aim to meaningfully reducing the data to codes that can be used for further *explanation*.

At the same time, the methods differ in some ways. First, the size of constituents that is being analyzed in each method differs: process coding looks at chunks of data focusing on observable actions, whereas concept coding looks at the largest constituents. Also, the pointers to each coding method differ: in process codes, pointers are observed in sequences of actions and reactions; in concept codes they are observed in transitions in topics. Furthermore, the level of abstraction in each method differ: moving from concrete codes to the more conceptual codes in process coding method; to the abstract, creative and

evocative codes in concept coding. Given these observations, the amount of work and level of difficulty of coding increases as one moves from process to concept coding.

In coding, process coding was the initial step, but the coding gradually moved to concept coding. In the analysis, a few factors were considered:

- **Number of interviews:** With the moderate number of 14 interviews, given the length and level of detail of each interview, process coding was used as a starting point, followed by process coding.
- **The purpose of the research:** Because the qualitative phase aims to *explain* the quantitative phase, the use of concept coding at later stage was favorable.
- **The structure of the interview protocol:** Because the interview protocol follows the self-regulation cycle in adaptability, it therefore provides a semi-structure with direct prompts asking participants to describe their behavior in adaptation. Realizing that different participants may have different processes with different responses and levels of details, concept coding may help in capturing the variation of interest.
- **Order of analysis conducted:** Finally, because the researcher was both the person responsible for data collection and data analysis, and being aware of the scope and interest of the qualitative, follow-up study, the order of analysis of interviews allowed the emergence of themes of interest that would *explain* the quantitative findings (e.g., differences between teaching- and research-focused faculty participants). The analysis started from process coding and moved to concept coding. Otherwise, starting, say, from concept

coding and moving backwards, may not provide meaningful concept codes as those tend to be highly abstract. Therefore, because of the degree of abstraction that corresponds with each coding method, the decision was to first start with process coding of few transcripts, and then follow by concept coding.

2.7 Quality considerations

Validity issues and subjectivity statement

Some of the validity issues in this research design include theoretical validation and procedural validation. Theoretical validation refers to capturing the full extent of the phenomenon under study (Walther, et. al., 2013); that is adaptation as a process in curricular change. Because of the temporal gap between the events that faculty will try to recall in the interview and the time of the interview, they may provide inaccurate self-assessments (McClelland, 1998; Spencer & Spencer, 1993), or produce a bias in self-reporting (Maxwell, 2005). One way to mitigate this is during the interviews: the interviewer might push for eliciting memories that are newer to the faculty member (Walther, et al., 2011). Because such moments can be described with vague feelings and surprise moments (Dewey, 1933), triangulation explanations with faculty and their accounts after the analysis can be one way to increase validity of the research (Gibbs, 2007).

Procedural validation is reflected in the influence of questionable contributions that may provide a threat to the analysis of the data. Walther et al. (2013) suggested triangulation as one strategy for mitigation. One element of procedure validation is the “role, influence,

and possible bias of the researcher” (p. 645). Personally, although I have a relevant engineering teaching background, I did not experience the curriculum change in either context of this study. During my data collection and analysis, I was a graduate research assistant with full research assignment. I developed familiarity with initiatives around the entrepreneur mindset and the KEEN network through my involvement with related extra-curricular activities on-campus. To mitigate the influence of my experience on procedural validation, I developed a systematic documentation of observations and interactions with faculty participants, in addition to gradual coding to achieve higher levels of abstraction (Flick, 2006).

Reliability assessment

In order to assess the reliability of using the codes (Appendix I), the full transcripts were shared along with the codebook with another researcher. A introductory meeting was held with the researcher to explain the research purpose and data structure. Inter-rater reliability assessment was made for codes by speaker-turn, where a “speaker-turn” is defined as the length of time the participant talks before the interviewer talks again (this could be multiple paragraphs or a few words). The completed coding by myself as the main researcher were not shared with the other coder except for the coding of one interview provided as an example. The other coder conducted the coding for one additional interview, and another meeting was held to discuss findings. After explaining some of the nuances of the codebook, the coding proceed by the other coder for Context 1 first. Then, another meeting was held

to explain the specific features of Context 2 and how the same codes were applied to interviews in the second context.

Once the coding was complete by the second coder, a matrix was created: for each speaker-turn segment of the transcript, 0's and 1's were used for each code (not applied or applied to that segment). After the matrix was complete, and with only two coders, Cohen's kappa was calculated to establish inter-rater reliability per code. The results are included in Table 22, indicating that a "substantial" level of agreement was achieved which is statistically significant.

Table 22. Results of inter-rater reliability analysis.

Code	Cohen's Kappa	<i>p</i>
Planning W	0.713	0.000
Planning SE	0.745	0.000
Adjusting W	0.790	0.000
Adjusting SE	0.684	0.000
Reflecting W	0.605	0.000
Reflecting SE	0.767	0.000

4. Limitations and subjectivity statement

This study has contextual limitations, methodological limitation and data limitations. The contextual limitations are related to the fact of the specialized an unique contexts chosen to compare the two groups of faculty (i.e., the EM- and the COVID-contexts). Although insightful, in order to understand faculty adaptability in different contexts of curricular change, other contexts, with varying situational strengths should be explored. At the same time, the established reliability of the used instruments in this study can be a starting point for exploring faculty adaptability in other contexts.

This study is also limited by methodological (or procedural) limitations. More specifically, the utilization of an survey instrument along with an interview protocol may not necessarily fully capture the essence of faculty adaptability. The instrument which was designed for this study, for example, although every effort was made to make it provide comprehensive results, its deployment during the pandemic may have had its influence on faculty's responses. A thoughtful effort has been made to encourage faculty to focus during their responses on specific contexts, but this may have been limited. Also, the interview protocol, although provocative and engaging, and that faculty were able to share thoughtful responses, may have missed some nuances of faculty adaptability. Because it was reflective in nature, faculty responses may have been more idealistic than what takes place in their behavior and activities. The semi-structured nature of the interview protocol allowed exploring different experiences by faculty but at the same time it may have missed some key factor enabling or prohibiting certain behavior of faculty.

This study is also limited by the data collected. The level of variations across subgroups may have been limited (e.g., years of experience subgroups, teaching- and research-focused subgroups, gender subgroups, and ethnicity subgroups). In addition, collected data may have missed equal representation from different contexts in the sense that faculty recruited from a place where EM is being integrated in a certain way may have different responses from a place where EM is being integrated in a different way. The same in the COVID-context, where different institutions responded differently to the pandemic. Overall, however, despite the low rate of response, and with the significant effort to achieve

equal representation, a more systematic, widely-organized effort may help in refining the results of this study.

CHAPTER 4

QUANTITATIVE ANALYSIS RESULTS

Comparisons across contexts

Means analysis

Mean scores and standard deviations, for attitude toward context (*clarity* and *constraints*) and self-efficacy and willingness (for *planning*, *adjusting* and *reflecting*), and a comparison between means across contexts are shown in Table 23. Differences between attitude toward *context's clarity* and *context's constraints* were not significant. Faculty participants reported similar attitude toward *context's clarity* in the EM context (mean 6.83; range between 3.78 and 9.56) and the COVID context (mean 6.86; range between 3.40 and 10.00). Similarly, faculty participants reported similar attitude toward *context's constraints* in the EM context (mean 5.25; range between 2.00 and 9.50) and the COVID context (mean 5.73; range between 2.00 and 10.00). The average scores for *self-efficacy* and *willingness* measures were also similar across contexts, with *willingness for planning* scores being the highest for participants in both groups, and *self-efficacy in reflecting* being the lowest (see Table 23).

Table 23. Mean scores, standard deviations, and comparisons of means across contexts ^a

	C1: EM	C2: COVID	p-Value
Attitude toward Clarity	6.83 (1.21)	6.86 (1.30)	NS
Attitude toward Constraints	5.25 (1.65)	5.73 (1.70)	NS
Planning SE	7.44 (1.15)	7.47 (1.48)	NS
Planning W	8.25 (1.25)	8.30 (1.30)	NS
Adjusting SE	7.05 (1.39)	7.42 (1.35)	NS
Adjusting W	7.88 (1.54)	8.19 (1.20)	NS
Reflecting SE	6.69 (1.39)	6.69 (1.39)	NS
Reflecting W	8.11 (1.54)	7.91 (1.27)	NS

^aStandard deviations are in parentheses.

Correlations

The results of analyses of correlations among both *self-efficacy* and *willingness* scores with *attitude toward context* scores are shown in Table 24. Overall, the correlations suggest that the relationship between *self-efficacy* and *willingness* scores and *attitude toward context* score are higher among faculty participants in the COVID context. There are three major additional observations associated with these correlational findings. First, when observing the statistical significance of correlations, in the EM context, the *self-efficacy in adjusting*, *willingness for adjusting* and *willingness for planning* scores were not significantly correlated with both attitude toward context's *clarity* and context's *constraints* scores; however, the non-significant correlations went in the same direction as the corresponding significant correlations in the COVID context. In the COVID context, the *willingness for adjusting* scores were not significantly correlated with the attitude toward the *constraint* of the context scores.

Table 24. Correlations among self-efficacy and willingness measures and attitude toward context measures.

	C1: EM		C2: COVID	
	Clarity	Constraints	Clarity	Constraints
Planning SE	0.34**	0.27*	0.64**	0.40**
Planning W	0.18	0.18	0.54**	0.28**
Adjusting SE	0.15	0.14	0.48**	0.39**
Adjusting W	0.20	0.20	0.33**	0.11
Reflecting SE	0.50**	0.36**	0.60**	0.44**
Reflecting W	0.50**	0.36**	0.38**	0.24*

*** $p < 0.001$

** $p < 0.01$

* $p < 0.05$

A second observation is that, in both contexts, correlations between attitude toward context's *clarity* with both *self-efficacy* and *willingness* were higher, in both contexts, compared to

the correlations with attitude toward context's *constraints*. A third observation is that a large Pearson's r correlational factor is observed: in the EM context, between attitude toward *clarity* with both *self-efficacy in reflecting* and *willingness for reflecting* ($r = 0.50, p < 0.001$, in both); and, in the COVID context, between attitude toward *clarity* and *self-efficacy in planning* ($r = 0.64, p < 0.001$), *willingness for planning* ($r = 0.54, p < 0.001$), *self-efficacy in adjusting* ($r = 0.48, p < 0.001$), and *self-efficacy in reflecting* ($r = 0.60, p < 0.001$).

Multiple regression analyses

For the responses of faculty participants in the EM context, a multiple regression analysis showed that the attitude toward context's *clarity* explained 10.3% of variability² ($p < 0.01$) in *self-efficacy in planning*, while attitude toward context's *constraints* explained 5.8% of variability ($p < 0.05$) in *self-efficacy in planning*. With both in the model to predict *self-efficacy in planning*, only the attitude toward context's *clarity* was significant, explaining 9.5% of variability ($p < 0.05$).

In addition, attitude toward context's *clarity* explained 24.4% of variability ($p < 0.001$) in *self-efficacy in reflecting*, while attitude toward context's *constraints* explained 11.5% of variability ($p < 0.01$) in *self-efficacy in reflecting*. With both in the model to predict *self-efficacy in reflecting*, only the attitude toward context's *clarity* was significant, explaining 23.5% of variability ($p < 0.001$). No other significant models were found to correlate the attitude toward context's *clarity* with *self-efficacy* or *willingness* measures in the EM-context sample.

² Adjusted R².

For the responses of faculty participants in the COVID context, a multiple regression analysis showed that the attitude toward context's *clarity* explained 39.7% of variability ($p < 0.001$) in *self-efficacy in planning*, while attitude toward context's *constraints* explained 15.1% of variability ($p < 0.001$) in *self-efficacy in planning*. With both in the model to predict *self-efficacy in planning*, only the attitude toward context's *clarity* was significant, explaining 38.9% of variability ($p < 0.001$).

In addition, the attitude toward context's *clarity* explained 27.7% of variability ($p < 0.001$) in *willingness for planning*, while attitude toward context's *constraints* explained 6.7% of variability ($p < 0.05$) in *willingness for planning*. With both in the model to predict *willingness for planning*, only the attitude toward context's *clarity* was significant, explaining 27.6% of variability ($p < 0.001$).

Also in the COVID-context, the attitude toward context's *clarity* explained 21.9% of variability ($p < 0.001$) in *self-efficacy in adjusting*, while attitude toward context's *constraints* explained 14.4% of variability ($p < 0.001$) in *self-efficacy in adjusting*. With both in the model to predict *self-efficacy in adjusting*, only the attitude toward context's *clarity* was significant, explaining 21.9% of variability ($p < 0.001$).

The attitude toward context's *clarity* explained 9.6% of variability ($p < 0.01$) in *willingness for adjusting*, while attitude toward context's *constraints* could not predict *willingness for adjusting*.

The attitude toward context's *clarity* explained 34.6% of variability ($p < 0.001$) in *self-efficacy in reflecting*, while attitude toward context's *constraints* explained 18.6% of variability ($p < 0.001$) in *self-efficacy in reflecting*. With both in the model to predict *self-efficacy in reflecting*, only

the attitude toward context's *clarity* was significant, explaining 34.2% of variability ($p < 0.001$).

Finally, in the COVID-context, the attitude toward context's *clarity* explained 13% of variability ($p < 0.001$) in *willingness for reflecting*, while attitude toward context's *constraints* could not predict *willingness for reflecting*. No other significant models were found to correlate the attitude toward context's *clarity* with *self-efficacy* or *willingness* measures in the COVID-context sample.

Comparisons within contexts

Role-type differences

Means analysis

Mean scores and standard deviations for both *self-efficacy* and *willingness* measures as well as attitude toward context measures, for Group A (lecturers, senior lecturers, or adjunct) and Group B (assistant, associate, or full professor) faculty participants across each context, are shown in Table 25. I. In the EM-context sample, Group A and Group B faculty did not have significantly different *self-efficacy* scores, in planning, adjusting and reflecting. Notably, when comparing achieved scores across *self-efficacy* measures, both groups scored the highest in *self-efficacy in planning*, then in *self-efficacy in adjusting*, while *self-efficacy in reflecting* scores were the lowest and almost neutral. Interestingly, in the EM-context sample, there were significant differences in *willingness* measures (see Table 25). The *willingness for planning* of Group A faculty was significantly higher than the *willingness for planning* of the Group B faculty in the

EM-context (means = 8.75 and 7.81, respectively, $p < 0.001$, with large effect size, Cohen's $d = 0.82$).

Furthermore, the *willingness for adjusting* of Group A faculty was significantly higher than the *willingness for adjusting* of Group B faculty in the EM-context (means = 8.45 and 7.39, respectively, $p < 0.01$, with large effect size, Cohen's $d = 0.74$). Also, the *willingness for reflecting* of Group A faculty was significantly higher than the *willingness for reflecting* of the Group B faculty in the EM-context (means = 8.48 and 7.78, respectively, $p < 0.05$, with medium effect size, Cohen's $d = 0.47$).

In the COVID-context sample, both groups did not, overall, have significantly different *self-efficacy* and *willingness* scores, in *planning*, *adjusting* and *reflecting* (Table 25). Notably, the *willingness for planning* of Group A faculty was significantly higher than that of Group B in the COVID-context (means = 9.00 and 8.09, respectively, $p < 0.01$, with large effect size, Cohen's $d = 0.67$).

Table 25. Means and standard deviations across role-type within each context. ^{a, b}

	C1: EM			C2: COVID		
	Group A	Group B	<i>p</i> -Value	Group A	Group B	<i>p</i> -Value
Planning SE	7.51 (1.18)	7.38 (1.14)	NS	8.00 (1.45)	7.31 (1.47)	0.082
Planning W	8.75 (0.96)	7.81 (1.31)	0.001***	9.00 (1.54)	8.09 (1.51)	0.008**
Adjusting SE	7.21 (1.44)	6.90 (1.36)	NS	7.82 (1.66)	7.30 (1.24)	NS
Adjusting W	8.45 (1.14)	7.39 (1.68)	0.002**	8.58 (1.56)	8.08 (1.06)	NS
Reflecting SE	6.64 (1.97)	6.74 (1.55)	NS	7.17 (1.54)	6.56 (1.32)	NS
Reflecting W	8.48 (1.33)	7.78 (1.65)	0.049*	8.22 (1.75)	7.82 (1.10)	NS
Clarity	6.80 (1.23)	6.85 (1.21)	NS	7.34 (1.13)	6.72 (1.33)	0.071
Constraints	5.21 (1.65)	5.28 (1.67)	NS	6.31 (1.11)	5.56 (1.81)	NS

^a Standard deviations are in parentheses.

^b Group A: Self-identified as “lecturers, senior lecturers, or adjunct”; Group B: Self-identified as “assistant, associate, or full professor”

*** $p < 0.001$

** $p < 0.01$

* $p < 0.05$

When looking at the differences between *attitude toward context*, faculty participants scored almost neutral scores of attitude toward context's *constraints* (around 5 out of 10) in both groups in the two contexts, while scores of attitude toward context's *clarity* were slightly higher. In the EM-context sample, there were no significant differences between faculty in Groups A and B in both attitude toward context *clarity* and attitude toward context *constraints*. Similarly, in the COVID-context sample, there were no significant differences between faculty in Groups A and B in both attitude toward context *clarity* and attitude toward context *constraints*.

Correlations

The results of the correlation analyses for the *self-efficacy* and *willingness* scores with *attitude toward context* scores, for Groups A and B are shown in Table 26. In the EM-context, for faculty in Group A there was almost no significant correlation between *self-efficacy* and *willingness* scores with *attitude toward context* scores, except for the *self-efficacy in reflecting* which was correlated with attitude toward context *clarity* with a medium correlation ($r = 0.41, p < 0.05$). For Group B faculty in the EM-context, the attitude toward context *clarity* was correlated with *self-efficacy in planning* ($r = 0.39, p < 0.05$), *self-efficacy in adjusting* ($r = 0.39, p < 0.05$), and *self-efficacy in reflecting* ($r = 0.58, p < 0.01$). Furthermore, for Group B in the EM context, the attitude toward context *constraints* was correlated with *willingness for planning* ($r = 0.33, p < 0.05$), and *self-efficacy in reflecting* ($r = 0.39, p < 0.05$). Overall, *self-efficacy* and *willingness*

scores of Group B faculty in the EM-context showed higher levels of correlations with *attitude toward context* compared to scores of Group A faculty.

In the COVID-context, and similar to the findings for the entire samples (Table 24), correlations between *self-efficacy* and *willingness* scores with *attitude toward context* scores were higher compared to the faculty sample in the EM-context. For Group A faculty in the COVID-context, the attitude toward context *clarity* was correlated with *self-efficacy in planning* ($r = 0.67, p < 0.01$), *self-efficacy in adjusting* ($r = 0.54, p < 0.05$), *willingness for planning* ($r = 0.69, p < 0.01$), and *willingness for reflecting* ($r = 0.48, p < 0.05$).

Table 26. Pearson correlations for SE and W of adaptability phases and attitude toward context across role-type within each context. ^a

	C1: EM				C2: COVID			
	Group A		Group B		Group A		Group B	
	Clarity	Constraints	Clarity	Constraints	Clarity	Constraints	Clarity	Constraints
Planning SE	0.29	0.25	0.39*	0.28	0.67**	0.30	0.61**	0.40**
Planning W	0.11	0.01	0.27	0.33*	0.69**	0.31	0.46**	0.24
Adjusting SE	-0.10	-0.02	0.39*	0.29	0.54*	0.51*	0.44**	0.37**
Adjusting W	0.13	0.09	0.29	0.31	0.46	0.18	0.25	0.07
Reflecting SE	0.41*	0.32	0.58**	0.39*	0.46	0.43	0.61**	0.45**
Reflecting W	0.04	-0.01	0.23	0.18	0.48*	0.45	0.32*	0.19

^a Group A: Self-identified as “lecturers, senior lecturers, or adjunct”; Group B: Self-identified as “assistant, associate, or full professor”

*** $p < 0.001$

** $p < 0.01$

* $p < 0.05$

Furthermore, for Group A faculty in the COVID-context, the attitude toward context *constraints* was only correlated with *willingness for adjusting* ($r = 0.51, p < 0.05$). For Group B faculty in the COVID-context, the attitude toward context *clarity* was correlated with *self-efficacy in planning* ($r = 0.61, p < 0.01$), *self-efficacy in adjusting* ($r = 0.44, p < 0.01$), and *self-efficacy in reflecting* ($r = 0.61, p < 0.01$). In addition, for the same group of Group B faculty in the COVID-context, the attitude toward context *clarity* was correlated with *willingness for planning* ($r = 0.46, p < 0.01$) and *willingness for reflecting* ($r = 0.32, p < 0.05$). As for the attitude toward context *constraints* for Group B faculty in the COVID-context, it was correlated with *self-efficacy in planning* ($r = 0.40, p < 0.01$), *self-efficacy in adjusting* ($r = 0.37, p < 0.01$), and *self-efficacy in reflecting* ($r = 0.45, p < 0.01$). It was not correlated with any of the *willingness* measures.

In addition to the observation of the higher, overall, more significant correlations of the COVID-context compared to the EM context, two major observations can be made. First, as shown in Table 26, Group B faculty, in both contexts, show significant correlations between attitude toward context *clarity* measures and *self-efficacy* measures (*planning, adjusting, and reflecting*). Second, the *willingness for adjusting* did not have any significant correlations with *attitude toward context*, in both contexts, for both Groups A and B.

Multiple regression analyses

Results of multiple regression analyses for both Groups A and B faculty in both contexts are shown in Table 27. The table shows only significant relationships found in regression analyses; no other significant interactions were identified. Notably, the attitude

toward context's *clarity* in the COVID-context provides high level of explanation of *self-efficacy* and *willingness* measures in that context.

Table 27. Results of multiple regression analyses for both Groups A and B faculty in both contexts. ^{a, b}

C1: EM, Group A	
	Attitude toward <i>context clarity</i> explained 13.9% of variability ($p < 0.05$) in <i>self-efficacy in reflecting</i>
C1: EM, Group B	
	Attitude toward <i>context clarity</i> explained 12.7% of variability ($p < 0.05$) in <i>self-efficacy in planning</i>
	Attitude toward <i>context constraints</i> explained 8.5% of variability ($p < 0.05$) in <i>willingness for planning</i>
	Attitude toward <i>context clarity</i> explained 13.1% of variability ($p < 0.05$) in <i>self-efficacy in adjusting</i>
	Attitude toward <i>context clarity</i> explained 31.8% of variability ($p < 0.001$) in <i>self-efficacy in reflecting</i>
C2: COVID, Group A	
	Attitude toward <i>context clarity</i> explained 41.9% of variability ($p < 0.01$) in <i>self-efficacy in planning</i>
	Attitude toward <i>context clarity</i> explained 44.2% of variability ($p < 0.01$) in <i>willingness for planning</i>
	Attitude toward <i>context clarity</i> explained 24.7% of variability ($p < 0.05$) in <i>self-efficacy in adjusting</i>
	Attitude toward <i>context clarity</i> explained 18.3% of variability ($p < 0.05$) in <i>willingness for reflecting</i>
C2: COVID, Group B	
	Attitude toward <i>context clarity</i> explained 35.9% of variability ($p < 0.001$) in <i>self-efficacy in planning</i>
	Attitude toward <i>context clarity</i> explained 19.7% of variability ($p < 0.001$) in <i>willingness for planning</i>
	Attitude toward <i>context clarity</i> explained 18.2% of variability ($p < 0.001$) in <i>self-efficacy in adjusting</i>
	Attitude toward <i>context clarity</i> explained 35.9% of variability ($p < 0.001$) in <i>self-efficacy in reflecting</i>

^a Only significant interactions are reported here.

^b Group A: Self-identified as “lecturers, senior lecturers, or adjunct”; Group B: Self-identified as “assistant, associate, or full professor”

Years of teaching differences

Analysis of variance

Categorized differences in *self-efficacy in* and *willingness for planning, adjusting and reflecting*, as well as attitude toward context's *clarity* and *constraints*, categorized by years of teaching experiences, are reported in Table 28 for each context. No significant differences due to years of teaching experience were found. Faculty participants in each of the three levels of years of experience (0-5 years, 6-10 years, and more than 10 years of experience) scored consistently across all measures in both contexts. Achieved power was for Context 1 was 0.47, and for Context 2 was 0.49.

Multiple regression analyses

Interactions between the three levels of years of teaching experience and attitude toward context were examined to determine whether they predicted *self-efficacy in* and *willingness for planning, adjusting and reflecting*. No significant models of years of teaching experience were found to predict *self-efficacy in* and *willingness for planning, adjusting and reflecting* in either contexts.

Table 28. Mean differences, categorized by years of teaching experience, for self-efficacy in and willingness for planning, adjusting and reflecting as well as attitude toward context clarity and constraints, for each context.

C1: EM (N = 75)					
Years of experience					
	0-5 Years (n = 21)	6-10 Years (n = 16)	> 10 Years (n = 38)	<i>F</i> -value	Sig
Planning SE	7.26	7.28	7.60	0.77	NS
Planning W	8.28	8.20	8.25	0.02	NS
Adjusting SE	7.45	6.94	6.87	1.25	NS
Adjusting W	8.10	7.98	7.73	0.42	NS
Reflecting SE	6.93	6.40	6.68	0.67	NS
Reflecting W	8.04	8.30	8.06	0.16	NS
Clarity	6.76	6.99	6.80	0.12	NS
Constraints	5.26	5.34	5.20	0.04	NS
C2: COVID (N = 80)					
Years of experience					
	0-5 Years (n = 28)	6-10 Years (n = 13)	> 10 Years (n = 39)	<i>F</i> -value	Sig
Planning SE	7.33	7.42	7.58	0.24	NS
Planning W	8.21	8.31	8.35	0.09	NS
Adjusting SE	7.03	7.57	7.64	1.82	NS
Adjusting W	7.98	8.19	8.35	0.75	NS
Reflecting SE	6.39	7.08	6.78	1.24	NS
Reflecting W	7.74	7.97	8.02	0.38	NS
Clarity	6.66	7.52	6.78	2.16	NS
Constraints	5.83	6.34	5.46	1.39	NS

Gender differences

Means analysis

Mean scores and standard deviations for both *self-efficacy* and *willingness* measures as well as *attitude toward context* measures, categorized by reported gender, are included in Table 29 for each context. The analysis conducted here was just for the two gender identities (males and females). The low number of respondents who identified as “other” (2 in each context) is a limitation in this sample. Differences were not significant across the groups in the gender category except for *self-efficacy in adjusting* in the EM-context, where the post-hoc analysis shows the difference to be mainly between male and female participants (means = 7.45 and 6.94, respectively, $p < 0.05$, with large effect size, Cohen’s $d = 0.69$). Achieved power was for Context 1 was 0.50, and for Context 2 was 0.44.

Multiple regression analyses

Interactions between gender and attitude toward context were examined to determine whether they predicted *self-efficacy in* and *willingness for planning, adjusting and reflecting*. In the EM-context, gender, as a predictor, explained 7.7% of variability ($p < 0.05$) in *self-efficacy in adjusting*. Gender was shown to have limited interaction with *attitude toward context*. When attitude toward context’s *clarity* was added to gender as predictors, the model explained 8.8% of variability ($p < 0.05$) in *self-efficacy in adjusting*. When attitude toward context’s *constraints* was added to gender as predictors, the model explained 8.3% of variability ($p < 0.05$) in *self-efficacy in adjusting*. When attitude toward both context’s *clarity* and *constraints* were added to gender as predictors, the model explained 7.7% of variability ($p < 0.05$) in *self-efficacy in adjusting*. No

other significant models of years of teaching experience were found to predict *self-efficacy in* and *willingness for planning, adjusting and reflecting* in either contexts.

Table 29. Mean differences, categorized by reported gender, for self-efficacy in and willingness for planning, adjusting and reflecting as well as attitude toward context clarity and constraints, for each context.^a

	C1: EM (N = 75)		
	Gender		
	Male (n = 51)	Female (n = 22)	p-value
Planning SE	7.49 (1.20)	7.27 (1.09)	NS
Planning W	8.31 (1.31)	8.13 (1.17)	NS
Adjusting SE	7.34 (1.24)	6.36 (1.59)	*
Adjusting W	8.03 (1.44)	7.56 (1.79)	NS
Reflecting SE	6.71 (1.30)	6.51 (1.57)	NS
Reflecting W	8.18 (1.40)	7.95 (1.91)	NS
Clarity	6.79 (1.22)	6.76 (1.13)	NS
Constraints	5.23 (1.75)	5.16 (1.38)	NS
	C2: COVID (N = 80)		
	Gender		
	Male (n = 61)	Female (n = 17)	p-value
Planning SE	7.63 (1.36)	6.89 (1.85)	NS
Planning W	8.33 (1.33)	8.24 (1.27)	NS
Adjusting SE	7.56 (1.34)	7.01 (1.28)	NS
Adjusting W	8.21 (1.28)	8.26 (0.87)	NS
Reflecting SE	6.83 (1.46)	6.32 (1.06)	NS
Reflecting W	7.98 (1.29)	7.76 (1.23)	NS
Clarity	6.87 (1.35)	6.81 (1.24)	NS
Constraints	5.78 (1.74)	5.65 (1.62)	NS

* $p < 0.05$

^a The low number of respondents who identified as “other” (2 in each context) is a limitation in this sample.

Summary of major results from quantitative phase

Overall, the most important quantitative finding was the distinctive patterns of correlations between *attitude toward context* scores and *self-efficacy* and *willingness* scores across the two contexts (Table 24), even though analysis showed no significant difference between *attitude toward context*, *self-efficacy* and *willingness* scores across the two contexts (Table 23) (Finding I). More specifically, in the COVID-context, faculty participants showed higher, and overall more significant, correlations between *attitude toward context* scores and *self-efficacy* and *willingness* scores compared to the EM-context. There were other important results from the quantitative analysis:

- Finding II. Correlations difference: In the comparison across contexts, correlations between *self-efficacy* and *willingness* scores with attitude toward *context's clarity* were generally higher than correlations with attitude toward *context's constraints* (Table 24). This may point to the need to explore how participants viewed *context's constraints* in the two contexts.
- Finding III. Means difference: In the comparison within the EM context, with respect to role-type differences, Group A faculty (self-identified as “lecturers, senior lecturers, or adjunct”) showed higher *willingness* for *planning*, *adjusting* and *reflecting* activities, compared to Group B faculty (self-identified as “assistant, associate, or full professor”) (Table 25). Also, in the COVID context, Group A faculty showed higher *willingness for planning* compared to Group B faculty. However, there were no other differences between both groups in the COVID context. This may point to the need to explore the *willingness* for change of Group A faculty in the EM context.

- Finding IV. Correlations difference: In the comparison within the EM context, with respect to role-type differences, Group A faculty showed no overall significant correlation with attitude toward context (except for the correlation between attitude toward *context's clarity* and *self-efficacy in reflecting*, Table 26). This may point to the need to explore the differences between Groups A and B faculty behaviors as they respond to contexts of curricular change.
- Finding V. Correlations difference: In the comparison within contexts, with respect to role-type differences, faculty participants' *willingness for adjusting*, in both contexts, and in both subgroups (A and B) was not correlated with neither attitude toward *context's clarity* nor attitude toward *context's constraints* (Table 26). This may point to the need to explore the *willingness for adjusting*, overall, as a step in faculty adaptability in response to the context of curricular change.

CHAPTER 5

QUALITATIVE FINDINGS

The purpose of the qualitative phase of the study is to understand faculty *behavior* during curricular change. The qualitative analysis is used to explore faculty activities during curricular change in the two different contexts. The central phenomenon under study in this qualitative phase is faculty activities as they are shaped by external forces during curricular change. This chapter builds on the summary of the major results from the quantitative phase, pointing to interesting finding that needs more explanation through the qualitative phase. The findings from the qualitative phase are shared as categories of themes, supported by responses from faculty participants, to illustrate contrasts and similarities of themes across the two contexts.

As discussed in Chapter 3, the mixed-method, quantitative-qualitative, sequential explanatory research design puts emphasis on the quantitative phase of data collection and analysis, followed by the qualitative phase to refine and explain results from the quantitative phase (Creswell, 2018). The exploratory nature comes from the inability to predict the external forces *a priori* in each context of the study, i.e., the enablers and barriers for *planning, adjusting and reflecting* during curricular change. Therefore, the major research question for this phase was:

How do faculty respond to curricular change, as exhibited in their activities of *planning, adjusting and reflecting* during change in divergent contexts?

1. Differences in *willingness for planning*

The *willingness for planning* illustrates the quality of being ready and prepared to organize teaching activities with forethought and anticipation of what might the activities involve or, consequentially, imply. This involves (1) forming **intention** to make and act upon plans as well as orienting oneself in reference to others; (2) **achievement motivation** to fulfill goals, increase competency, or seek positive judgement or avoid negative judgement; and (3) willingness for **allocating time and dedicating effort** for planning activities. Faculty participants portrayed varying levels of *willingness for planning* in the two contexts of this study.

2.1 Forming intention

Context I: The EM-context

In the EM-context, forming the intention to pursue a change in teaching could be inspired by work of some students, which encouraged a faculty member to further integrate the EM in his classes. For Robert, who is a faculty member in a teaching-focused university, the inspiration came many years ago from a student who had developed a portfolio of his work. This triggered interest in Robert to start exploring the idea of students developing portfolios of their work and engage students in storytelling activities around their portfolios—a significant component of integrating the EM:

“So he came to my office one day and wanted to show off this latest gadget that he 3D-printed. And then I asked him to show some other stuff. He goes, “Oh yeah!” So he goes go to this website and he had his own website of all the stuff that he had done. He had videos; he had still photos; he had pictures of the different designs; he was really in it. He was a skateboarder but he was really ... he was more into snowboarding. So he had snowboard designs, the graphics, as well as structural rigidity test, and the different simulations that he ran to see what type of materials would be most appropriate for a snowboard under these type of impacts. And that

was all on his website. And that's when it clicked for me that this is powerful. And at the time, we were a new engineering program, and our students were struggling with how do I describe to someone what type of engineer I am. And I saw the e-portfolio as a platform to actually do that on your own terms because if you ... I mean with this particular kid he had the arts; had the science; and had the engineering; all together in this multimedia platform that he designed that he put together and then was portable as long as you have internet access. And this was a means for me to say, "Okay, how do I afford these opportunities for my students?" So, that's when I started researching about the e-portfolio's, going to different conferences. partnering with individuals within KEEN. And that ranged [across different universities]. So from there, it was doing this over and over again, and seeing the power of our students, and seeing the students actually being hired not because of their resume, not because of their transcript, but because of their portfolio. And having a student who, in their LinkedIn profile (that was the other part of the classes, that they had to have a LinkedIn profile), he laid his e-portfolio on his LinkedIn profile. And that's how a major fortune 500 company sought him out, and hired him. And we have a couple of cases where students, because of their e-portfolio, they were hired as a result of it."

However, forming the intention for planning did not always align with the framing of the EM by KEEN. For Brooke, for example, who is a full professor in a large research university, the way EM was defined by KEEN did not quite align with the way she sees the importance of teaching students how to create value—another significant component of integrating the EM:

"I would say that I'm more into the first and the third, so making connections and then curiosity, less into creating value. Yeah because, again, that's a word that has a little bit of me ... yes, I understand value is defined more broadly, but I think the way that ... and again the current people are okay with that as well ... but that really has to do with money, right? They really want people to create value, which is creating businesses, which is creating money, and that doesn't really motivate me at all. So, when I do use the word value I think about it as value to a person, or valuing the person that we're working with."

A similar observation was made by Alex, who is has a lecturer, teaching-focused appointment in the same research university as Brooke. In Alex's comment below, his

comments align with the quantitative finding about how, within the EM context, teaching-focused faculty showed no overall attitude toward context (Finding IV):

“I mean, first of all, while I-University is part of the KEEN network, I would say if you came to I-University as an undergraduate or as a Master student, could you tell that KEEN was in any way, shape or form involved with I-University? I would say no. Very, very low key. There's a small group, like less than five, probably, members of faculty who would probably be even able to tell you what it is. Yet those five, of which I'm one, could probably tell you quite a lot about what it is. And we are in fact all design-based professors of some description, because, and I don't know if this is the truth of it, the word entrepreneur from entrepreneurial. Certainly, at I-University, and I can imagine that other universities, that have a similar look to I-University, is actually a dirty word, because it equates to the exploitation of science or technology in some way for money. And that word will immediately cause an allergic reaction in many members of faculty who will go, “Oh you just crossed the line into the world of business and commerce and making money and exploitation and that's not what I do. I'm a tenure track research professor working on the good of mankind.” So (and sometimes that's debatable) the KEEN entrepreneurial mindset, frankly, if you through 10 balls at I-University with KEEN entrepreneurial mindset, at I-University, nine of them would bounce off because the faculty would be like “Oh that sounds dirty to me. I'm not having anything to do with it.”

The way that forming an intention to plan activities in Context I as it related to faculty's attitude toward that context (Finding IV) is illustrated in the following response by Miles. Miles is a teaching-focused faculty and he describes the tension he sometimes faces:

“In my whole institution, I think I'm unique. In my department, maybe not. There are some of us in the [traditional departments]. Like not that they're happy, but like that's their main line. There are others of us, they don't really fit in that. I think we're always those others where we always trying to struggle and find out how we can put more of ourselves in. So [in other colleagues are from backgrounds where] those courses exist in the curriculum. So I think some people are always trying to get that stuff in, and they may or may not be successful. That's the internal politics of our department of what is in and what's not in terms of the mainline curriculum.”

The resistance that some faculty who have formed intention to participate in KEEN faced did not affect those faculty's intention to continue to pursue their activities (Finding

IV). Xavier, who teaches an R2 institution, commented on the relationship between those who were interested and those who were not as part of his institution's context to integrate the EM as follows:

“Like we kept with our plans; the faculty that wanted to join and connect, they have done and they are into KEEN at this point. Others, we keep trying; we keep inviting them; we keep conducting social activities; workshops ... some people go continuously, other guys always finding excuses. So we just let them in their own world, but we continue writing them. And we don't ... that doesn't make us stop. So we also keep our feeling that the KEEN ideology is important, so we truly believe that and we try to transmit it to our students as much as we can.”

For some faculty, the workshops conducted by KEEN were significant enablers for them to move their original interest to more impactful implementations. Vera teaches in another R2 university. She provided the following depiction of her intention formation to integrate the EM in two of her courses:

“I think in both of those cases ... they're both two different KEEN workshops. And so, most of the thinking about what am I going to do and how am I going to do it actually took place in the workshop because they give us time to do that. So the ideas been out there bounced around with different people at the same time, and at least laid the groundwork for doing it. And so that that was kind of the process, then I guess the follow-up work was just the boots on the ground—just you know getting it wrapped into the syllabus and thinking about rubrics and stuff like that. But yeah the bulk of it all was done as part of different KEEN workshops.”

The tension that a research-focused faculty member faces when trying to be involved in the KEEN activities (Finding III) was described by Jack, who has a teaching-focused assignment in a large research university. Jack was a tenured professor in another university before going to work in industry and then deciding to come back to teach in the university. He provided the following insight:

“You know, there is a problem there. Because tenure-track faculty who are going into tenure and promotion, from assistant to associate, they are walking the tightrope. I know because I walked that tightrope before. So your focus is “publish or perish.” The research bring money; that's your focus. All those the other activities are probably 10% of your weight of the evaluation. It doesn't count more. You could be an excellent instructor, excellent delivery, top notch, but if you don't bring money, you don't publish, not going to last on a tenure track. Might be okay as a lecturer but not as a tenure-track.”

Jack provided a unique observation on his involvement with the KEEN workshops and who gets involved in the KEEN activities. His observation highlights some of the enablers for faculty members of different role-types (like incentives) to get involved. In the following response, one can see that constraints on joining the KEEN activities were not present (Finding II). At the same time, the clarity in context of what faculty were doing and whether it was in concert with one another (Finding I) can also be seen in Jack's response:

“I will tell you the workshops I attended ... Initially, when I went there the first year, we were the [faculty who teach the] capstones. [...] Different areas, civil engineering, the chemical engineering, the computer science. Different areas but people had experiences. The second year, EM was lowered to second year, 200-level courses. So we started seeing lecturers with no experience. Fresh PhDs that started teaching, don't do research. Like lecturers. And it was there. And we started seeing tenure-track faculty, and they went there because they were invited, or they signed a paper for incentive to participate in this—I don't know why they were there. But definitely they were there. Did they learn? I don't know. I mean, are they applying them to their courses? [...] I don't know. I don't know that part. [...] And, to be honest, I don't know what other capstones are doing ... other capstones in chemical engineering, electrical ... I don't know what they do, how they applied.”

Context II: The COVID-context

For faculty participants in the COVID-context, it was difficult to form an intention for planning given the speed at which events took place when the pandemic's effect on

education started to become obvious. Miles, who teaches in a teaching-focused university, provided the following insight:

“So it was really tough to plan for the fall because the university kept saying, “Oh we're going to be in-person. Oh we're going to be in-person,” and everyone knew that was a lie. Like we were on in-person for five days—five class days, and then they threw everyone online for a month. And then it kind of came back on this weird hybrid area. And so, none of the students really wanted to come back after that because they'd already moved home. Like they'd come to campus; they lived here for a week or two; and then they were sent home, and they didn't want to come back again. So, honestly, I didn't plan that much for the fall because I didn't know what the situation would be. I didn't want to be indoors lecturing. So I literally pulled a whiteboard outside into a park near my building and like we had class outside for two days, for two lectures and then we were all kicked online. So, then I had to adapt and figure out what to do. Yeah, because there was so much uncertainty, I did not devote a ton of time to planning, because we just didn't know what would happen, because anything I put in, I was worried I'd have to scrap it.”

The lack of clarity of the context (“I didn’t know what the situation would be”) was strongly present in Mile’s response (Finding II). In addition, the influence of the context of his behavior (“So I literally pulled a whiteboard outside into a park near my building and like we had class outside”) was also present (Finding I). Faculty participants were also observing how the pandemic was unfolding in other places and were observing their campuses’ response. They did not seem to have seen the university’s response as a constraint (Finding II), even though it has affected their plans (Finding I). Xavier who teaches in an R2 university provided the following comment:

“I of course follow all the university guidelines because that is like their final word. But still I got influence ... I'm trying to remember how it happened. When I started hearing about COVID, I started doing my preparation, or I started thinking like what if COVID hit, what if we are locked down as they were doing in China and other places by January in February. So I started predicting that and I started trying to predict what will happen with the course or class activity and everything. Then, when the university finally took the decision on going online ... I think we locked down for one week ... one of just no classes ... and afterwards we continued online. And

yeah that was like time for me to plan and time to implement everything. It was challenging but luckily things went well, I believe.”

For Vagish, who is a tenure-track professor, in a large research university, the notion of “forming an intention to plan” during the emergence of the pandemic was not present, as he was just trying to “get through the semester.” Yet, as the pandemic persisted, he found an opportunity to collaborate with a colleague to find “creative ways” to deliver his course:

“Yeah so the first semester, the spring semester, we just didn't do any new activities; I was just trying to get through the semester. For the fall, I think a lot of it came from my colleague. He really didn't like the Zoom: it was kind of isolating, and it was hard to keep in touch with people, and stay on top of students and the interaction. And that class was very interaction-heavy. We do a lot of group work and a lot of stuff like that. So, he was really like I want to figure out creative ways to get students to connect to one another. And so that started the idea of like, okay, how are we going to actually enable these activities.”

The last response by Vagish helps to explain two unique findings from the quantitative phase as they relate to faculty participants’ *willingness for planning*. First, a similar pattern of how faculty seem to form intention for change (when they collaborate with other like-minded colleagues) can be observed between Context I and Context II, which may help explaining the lack of significant difference in the means across contexts (Finding I). Furthermore, as the pandemic persisted, faculty started to form intention to adapt (like in Vagish’s case, in order to deliver the quality they seek in their courses), which may explain the high correlations of *attitude toward context* and *willingness for planning* (Finding I).

2.2 Achievement motivation

In the EM-context, achievement motivation showed to be aligned with a profound interest in creating context for the engineering topics. Miles, for example, who is a teaching-focused faculty provided the following illustration:

“I’ve always been thinking about how much entrepreneur[ship] ... Let’s take a course. So in the same course, there’s a midterm project, where they have to take a thermistor, which is just to buy a device that changes its resistance based on temperature, and they have to make an LED thermometer out of it. And I can present that in a very dry and bland level, right? But I can try to embed, through the entrepreneurial mindset, I can try to embed some context and some interest around it, and so one thing I’ve tried to do, especially with that project, is find a more compelling application ... for I want them to be doing that project ... but I want to give them a more compelling narrative or context around it. So when they’re doing a project, maybe they’re a bit more engaged. And I think that’s sort of the theory is that, if our students are a bit more engaged in the topic, they’ll dive into it more, rather than just a bland sort of textbook problem.”

Kaleb, who leads the effort of integrating the EM in the curriculum on his campus, even before KEEN funded the effort, emphasized how he approached his planning so that he created value the same way he approached teaching creating value to the students:

“Yeah, I think that I strive to be, certainly. If only from the perspective of the end goal is to create things that work, to create value. And you try things and if you aren’t creating value for students, or if I’m not creating value for a learner, or if I’m not creating value for the world, I have to adapt so that I can actually do that. Like so my course isn’t working, I have to adapt if my end goal is actually to deliver value then I have no choice but to adapt. If I assess what’s going on and it’s not working or it can work better, I have no choice but to change my pedagogy; I have no choice but to change my course; I have no choice but to change the product that I’m offering. If I put the delivery of something of worth as my prime goal, so I think that’s the perspective I take.”

The response by Kaleb alluded to the major aspect of Finding IV where teaching-focused faculty attempted to advance their efforts for change regardless of the contextual factors of support or resistance. This is also illustrated in Vera’s response, who teaches in an R2

university. Vera tried to link the *curiosity* aspect of the EM with her experiences as a student and how she sees learning:

“Just from my experiences as a student and everything that I've also read or talked [about] in discussions, was anytime that you can have students driving it, again putting it in KEEN words, right? You're driving that curiosity, they're reflecting on things, so linking it to experiences that they have. And I think that always sticks more with people, at least it does for me, when I can link what I'm seeing into the classroom in something that maybe it's in my everyday life, or maybe in something I've seen in the news, it becomes personal, and then I think ... I don't know what the word is ... but, you know, it becomes embedded a lot easier than just sitting back as a passive receiver of knowledge. I don't think that sticks very well. So yeah I think that's the biggest motivation for me wanting to incorporate more of that type of thing. And to me it comes through, and you know these things that I've talked about with self-designed projects or labs, but also I do a ton of just very, very informal like, “Hey, ask your neighbor or group pair-share on it.” But just to have a pause and have people thinking on their own, I think, makes a big difference.”

A similar note was made by Jack, who is a teaching-focused faculty in large research university. Jack described his planning process as part of KEEN when he worked with a mentor, and showed similarities between the EM and his course planning:

“Yeah, yeah, with a curiosity first. That's the discovery. We discover, feel what they call the pain points. I was working with a faculty. He was helping me, guiding me. helping me structure my course. And when we know the pain point, then we have satisfied the curiosity. Now we're going to make the connection. How do I improve this? Or how do I create a better alternative? So the end has to be the creation of value. If there's no creation of value, and nobody wins.”

Faculty participants also showed achievement motivation in terms of interest in developing new skills. Jack, for example, described the benefit he got from participating in the KEEN activities on his campus, even though he already had familiarity with the KEEN process:

“Yes, yes, it gave me the structure, because we were doing things. We need to understand the client. We knew that; it's very simple. Someone who was on consulting, like I do, first thing I do is I sit down with the client and I understand. Take notes to make sure I understand the problem because I don't want to solve a

different problem that I'm not going to get paid for. And the same thing in industry. I tell my students, "Look, if you have the wrong problem on the table, you're going to solve another problem, which maybe wasn't a problem. And then, you think, after been working for a month or two, you think you have solved the problem. No, you haven't solved anything. You solved something that probably was there, was important, but it wasn't crucial, wasn't affecting the bottom line of your company, wasn't affecting the perception that the customer had about your company, wasn't decreasing the number of rejected units in the production line." So EM taught me that. They said, "We need to have a structure. We need to go to the discovery, first." Or, you know, what they call the three C's, right?"

The interest in developing new skills and its relationship with achievement motivation was illustrated in Mary's description of how she got first interested in engaging with KEEN:

"So what got me interested it was an email from some colleagues here, and I did a little bit of exploratory research on the KEEN program. Found it interesting and then the invite was basically that the my university had some money to send people to the KEEN conference beginning of January—maybe it was 2019 ... Anyway, so went to the conference and was really excited about it. A lot of great ideas; there are a lot of great collaborations. The courses I was most interested in were for senior design program. I am the communications advisor for senior design in our department. But also we have these for mechanical engineering practice courses. So these are a combination of lab and lecture that all of our undergraduate students are required to take. And I was interested. They're very hands-on classes and I was interested to learn what other people were doing and see if there were things that we could incorporate into our program, but mainly it was senior design."

Faculty participants described the context enablers, as well as barriers, for them to be motivated to be willing to plan and achieve new goals. Kaleb, who works in an institution that values educational innovation, when asked if he received any resistance, he quickly responded with, "No. Not, that one is easy. No." He then elaborated:

"I mean that's one of the amazing virtues ... I guess all were super engaged super excited. I mean our default is being excited about creating new things and iterating and exploring. So I think there's no lack of enthusiasm for that."

Different from Kaleb's response, who works in a teaching-focused university, is Alex's response, who has a teaching-focused assignment in a large research university. Alex described the how the notion of design started to emerge in the curriculum on his campus:

"I spent most of my time, more by luck than judgment, in the medical sphere. So in the biomedical engineering sphere of engineering, all things clinical and medical. [The] biomedical engineering undergraduate degree is hugely theoretical and very little application. I don't say that necessarily as a criticism, but there's an awful lot of heavy-duty academic work crammed into the undergraduate curriculum. And, at the most, universities that will involve wet lab skills and all manner of things, as well as you know, heavy-duty mathematics and the like and at the end of that four-year undergraduate in biomedical engineering, they do something called a capstone design project. Capstone being supposedly the, you know, the pinnacle of attempt, the stone on the top of their education, where basically often to a large extent, and not only at I-University, but at other biomedical engineering degrees, that's the first time that they're ever really given up thoroughly open-ended problem owned by a stakeholder where there is no known answer yet; you've got to design one.

And you know those projects, depending on the university, vary, you know, considerably in terms of complexity and outcome, to be honest, up until five years ago, or something like that, I-University didn't teach design in its undergraduate curriculum really at all until students got to the end of their junior or the beginning of their senior year and the capstone design project.

Other more enlightened universities like A-University absolutely embedded it in there BME degrees and I'm sure there in other degrees early on [...] But in BME there's so much heavy duty [...] there's so much theory you have to know before they're gonna let you design a door handle."

When asking Kaleb to reimagine a context different from his, where the same level of excitement about trying new educational interventions did not exist, he provided the following insight:

"I think I would strive to adapt; the ease of which it could ... would be a function of the institution. And maybe who knows, I mean I've spent a lot of time in my institution, maybe this is gonna go slightly meta, but my college is an environment that compels people to adapt to being adaptable. And so I can imagine people in other contexts where ... I mean this is maybe in some ways how you think about academia and there are institutions where the adaptation is to not be adaptable. Like in your teaching, for example, like there are instances where you know what it's

actually much more efficient and it's not value for you to invest a lot of time in your teaching, so you figure out the most efficient way to deliver this course, and you just deliver that same course over and over again. And that is an adaptation. That is an adaptation to a particular professional environment that manifests in certain schools in academia. So it's not lost on me that, "Yeah, this is probably my inclination. This is probably why old is a great fit for me." But I can't presume that if I ended up somewhere else I would land and ... I have to assume, in fact, that there would be some adaptation on my part, away from this flexibility, and away from this desire to emphasize value creation, especially as it relates to the student experience."

Faculty participants' *willingness for planning* in the EM-context seemed to motivated by the desire to making achievements, learning new skills and embracing enablers in the context.

Context II: The COVID-context

For faculty participants in the COVID-context, achievement motivation showed to be highly related to the desire to deliver quality instruction amidst the pandemic (Finding I). The impact of the pandemic on faculty's *willingness for planning* showed in different responses from faculty from various universities. Griffin, for example, who is a professor with a research focus in a large research university and who leads the capstone design coordination on his campus, described the impact of the pandemic on his planning effort to coordinate with industry partners:

"Okay, well, so the first real impact that the pandemic had on us was in January. We were doing our planning for the forum again, which is where the companies come together and present what they want the students to do. And it was a face-to-face event, and the day of the event, one of the company's called us and said they weren't coming because of the pandemic. And at the time we thought they're crazy; you guys are just way overreacting here. And so we went ahead; we assigned projects. In the first capstone, groups were working on their projects. And then we watched ... we sort of watched the pandemic news like everybody did, but I don't think we necessarily expected it to affect what we were doing very much. And so we didn't

really have any contingency plans worked out. And then during spring break, which I think was about March, around March 15th, we got an email from the administration, saying that everything was going virtual. And it was actually kind of interesting. Basically everything I was involved in, you know, from a personal perspective, also from work, went virtual that week. And all of a sudden, I'm going, "Wow, I guess I better pay attention here."

The influence of the context's clarity during the COVID pandemic on faculty's *willingness for planning* showed up in terms of the speed at which events were taking place.

Sophie was just hired to lead the first-year engineering experience at her large research university. She described her experience trying to plan the tasks assigned to her as follows:

"When I applied I assumed ... what I was hoping was that we would teach the same curriculum that was taught in the past couple of years and then adapt it for online and leave the big lift of curriculum development. And we knew ... my university always knew we wanted to redo the course entirely because it wasn't working. But I assumed the redoing of the course would have happened this summer, when things were going back to normal, and not last summer. So that I was not aware of ... is that by the time I came in that ship had sailed and they said you're redoing the course from scratch. The benefit is that I got to do what I wanted to do. So there is yes, I mean yeah, the answer is yes and no ... I knew I was being hired in the middle of pandemic. I knew we would have to transfer things to virtual. I didn't know I was going to have to develop a course from scratch last summer."

For Vagish, who is a research-focused professor in a large research university, the notion of *planning* to achieve a goal was not as important to him:

"Ah, you know, honestly I don't know if I definitely thought about that. I just was trying to get through the semester. So like yeah I wasn't sure how well it would go. I mean ... I just was like, well, you know, we would just kind of try very hard and see whatever landed. And the students really liked it, it seemed. We got pretty good evaluations and they seemed to really enjoy that. I think it's also like they just appreciated the effort. I think a lot of people stuck with the traditional lecture format and so on, and they liked that we put a lot of effort for that particular class to make it work. But yeah I don't know if I was like so intentional that I was gonna make this a regular part of my routine, or something. I think I just was like I needed to get through the semester, yeah."

Vagish’s response may help explain the interesting Finding I, that despite the notion that research-faculty said that they were not willing to plan in response to the pandemic, they were actually trying “very hard” to “see whatever landed.” Overall, in the COVID context, despite the impact the pandemic had on faculty’s efforts, they still showed *willingness for planning* to deliver quality teaching, even though that this “planning” may not have been in the very structured way of what we perceive of when hear the word.

2.3 Allocating time and dedicating effort

In the EM-context, allocating time represented the time that faculty put to engage in KEEN workshops and modify their courses to integrate the EM. This subtheme overlapped significantly with the previous subthemes on intention formation and achievement motivation under *willingness for planning*. For Miles, for example, that time during the workshops was the only time that he dedicated for planning:

“I have done [a KEEN] workshop and that has helped implementing changes, because they give you time in the middle of that. I also did a curricular design workshop here at my university. And so I made changes there. Honestly outside of those contexts, I kind of do it in the semester, right before the assignments are due. My summer time I really don't use for curricular development—I'll do a little bit like in August, but now in June and July, I've got to pick up research. I've got to pick up other things that along running. I gotta take a break. So my curricular design yes happens at workshops or happens in the week or two before something is due.”

Consider, as another example, Alex’s comments on the efficacy of the workshops and the effort put in integrating EM.

“I think every year we all kind of grown and say we need to be involved in the annual conference thing, that KEEN throw out. But we go to it, or this year it was virtual, and you're logged into a few sessions and things, and kind of sit quietly at the back. There is nothing going on. KEEN is bringing nothing to I-University. And I don't think anybody ... I think 95% of I-University wouldn't be interested if they came ...

wouldn't want to hear it. And the 5% that would be interested already know what they're doing [...] It's all over the summer. I mean literally the first summer I was there 2019, we built all of that material. And then we run the semesters and we're just like headless chickens and then we rejigger it if we need to or add or take away in the summer period. So that's when we do all the work, because when we're on nine month contracts so to speak ... so the summers are our own so that's when we did that work. [...] Nothing happens during the semester. Okay, once we start the semester it's like the running of the bulls.”

This lack of availability of enough time to make changes might explain the lack of significant difference between the EM-context and the COVID-context (Finding I): faculty participants in both contexts did not allocate significant time for change, either because they are busy with other work or because of the speed at which events happened.

Context II: The COVID-context

In the COVID-context, the interaction between faculty's willingness to allocate time and effort and the context of the pandemic (Finding I) is illustrated in Vera's insight on how the information she was getting about the situation were helping her in her planning efforts (Finding II):

“So I guess not really from outside sources, I'd say. It was a university direction. So how are we going to deal with these classes, what do we do, and then, as soon as they said, “You're not coming back. Start planning,” I immediately, on my timeline started making my preparations there: how am I going to change this, what does it do to my syllabus, how does it change my grading scale and everything else that I have. So I guess as soon as you know a little bit about the process moving forward from the university, you just go and start doing it, since it was such a short time frame.”

Vera's response allude to how faculty did not see of the university's direction to be *constraining* their behavior, as much as guiding their efforts during the pandemic. In addition,

Vera, who teaches in an R2 university, described how, despite previous basic use of online teaching technology, she was willing to put the effort based on what this technology can afford:

“Oh absolutely! I never used Teams or anything like that before. And I'd still wrote on a board in a classroom. And so you know all the things from learning to use our big tablets and Teams and Annotations and things like that, all of that was new. I had offered a course online before, and so I had come to use a software where I'd recorded. I was and still am a pretty basic user. So I don't know a lot of the high tech details. I do slides in and talk through them but allow it to at least edit and do things like that. So I had exposure to those tools. It allowed me to practice more with them and figure out things that colleagues said were best practices that they were learning at the same time. And so it'd still change things that I knew and most certainly introduced new things, specifically with classroom recordings and writing and things like that.”

For Griffin, who is a professor in a large research university, he described how he was allocating his effort to coordinate the senior design capstone offering during the pandemic:

“But yeah ... the hardest one I think was figuring out how to do the showcase virtually. And we went through a lot of different ideas. We ended up setting up five different Zoom meetings that would run simultaneously. And because we didn't really understand how to set up Zoom meetings, we had some technical issues that made that, you know, we had people dropping ... the faculty members who were hosting the meetings, we had them dropping out, not being able to get them back in. It was kind of a mess. I think all of the teams got to present eventually, but yeah it was pretty ... it was a mess. And so in terms of the effect that it had on the projects, there were some projects where they were working at home in the first place, or they went and got their stuff from the labs and finished them up at home. Some of those projects did very well. We have one project where the company had lent the students a robot. And once the building shut down, the company just went and got the robot, got all the stuff that the students have put together for their project. And the company actually finished their project and sent the students photographs and stuff. So you know the students actually had something to present but it wasn't work they had done. We had some projects that just shut down; there was no way for the students to do anything else. And so we encouraged them to try to come up with alternatives, you know, so rather than maybe doing their testing of their prototypes physically to do some simulations and stuff like that. And there was a really wide

range of what students were able to do. I mean some of them once things got shut down in March, that was kind of the end of their project work; others of them were very resourceful and managed to get some good stuff done. So it was a very broad spectrum of what they were able to do.”

Overall, across the two contexts, faculty seemed to be willing to engage in planning effort but that willingness showed differently. For faculty participants in the EM context, even though they showed interest in engaging in the KEEN activities, they ended up not putting the amount of time and effort into the change effort. In contrast, for faculty participants in the COVID context, even though they described the limited time they had to make changes, they ended up putting significant amount of time and effort into change. In both contexts, faculty were committed to delivering quality outcome to the students.

2. Differences in *self-efficacy in planning*

The *self-efficacy in planning* illustrates the quality of effectively being able to establish goals to implement changes in existing courses or curricular activities or introducing new courses and activities. This involves (1) making **decisions** about the selection, organization and sequencing of course materials and routines; (2) developing a **systematic** process for changing an existing course or introducing a new course or activity (as opposed to fine-tuning techniques); and (3) dedicating **time and effort** for change. Faculty participants portrayed varying levels of *self-efficacy in planning* in the two contexts of this study.

2.1 Making decisions

Context I: The EM-context

In the EM-context, making decisions involved setting goals and developing an action plan to reach those goals. Brooke leads the first-year engineering course effort and coordinates the activities of multiple sections. For Brooke, who is a full professor in her large research university, making decisions involves lots of organization effort:

“I am the director of the program, and there are like 13 of us who teach it in order to get all the students covered, with some reasonable faculty student ratio. There are large group of people so it's like I'm the leader and then we're kind of go together through the semester. So I do a lot of organization. I do a lot of scoping of the projects. And then we all teach together in different sections, but we use a common format.”

For Kaleb, who teaches at a teaching-focused institution, making decisions showed in an internal effort to grow entrepreneurship on his campus:

“I was part of the small task force that reexamined entrepreneurship at the college and we generated a White Paper for our internal use as a consequence of that and identified opportunities for improving, sort of growing, entrepreneurship at the college. And from the faculty perspective, as a faculty member, I took a charge. I picked up the flag and was pushing those things. [...] Certainly one of the dominant means of impacting a culture in an academic setting is courses, like fundamentally changing student experiences. [...] So moving this course to one that is in the first year of students' experience as opposed to one that they can take it anytime—that was a significant shift, “Let's make sure that we get it in early.” That's a big deal because, again, for all the things I just mentioned, that was one of the shifts there. We made it a team talk course and a studio project-based course. So pulled in other faculty from the college into the teaching of the course which we do for a number of sort of core courses. But, historically, this was not one of the courses that it was done for. So that changed the footprint from the student experience standpoint and also changed the ... it further changed the number of faculty. The percentage of faculty that thought about these things engaged in teaching around entrepreneurship and integrated into ways that they thought. By extension it also influenced what they could take from what we taught in this early course and then integrate into their later courses that might not necessarily be entrepreneurship courses, might be other engineering courses, but it's a mechanism of sharing, and sort of diffusing, some of this entrepreneurial thinking throughout the rest of the college by virtue of having this class other faculty pass through and participating, and then go out and share those ideas other places.”

In Kaleb’s example, the scale of impact of decisions made is observed as it gradually affected his college. Ralph reported a slightly similar perspective but with a different scale of impact. In his response, Ralph referred to the use of e-portfolios by students—a digital collections of students’ work throughout their involvement in the curriculum—and how he helped them tailor their portfolios to their interests:

“Well, it really depends. For the first-year course, it was something small because the first-year course what you're really trying to do is get them aware of the process. So let's say you had a project in one of your other classes, not an engineering class, and you did a really good job, and let's say you got an A on it, you don't throw that just in your e-portfolio. What you have to do is that's an artifact; you have to turn it into evidence of your learning. So that requires you understanding what you were asked to do, what you did, and how that became something of significance to you. So that process of reflection of What?—So what?—Now what? [...] So, one of the projects that a student came to me about was they had this structural analysis in statics and dynamics, and they spent a lot of time and a lot of effort. They did a lot of research on it, and they said “Could I use this as an artifact or evidence?” I'm like, “Yeah, but what's the story? What did you gain from it?” And then helping them to develop that story, and what they gained from it, and how might they see them using it in the future. That's when it turns into evidence of their learning. And then, for the juniors and seniors, since this was a wholesale implementation this past year, that's one of the things that we found, is the different levels: their interest changed based off of where they are, which should be the case. So with your seniors, they're trying to take the perspective of potential employers in some cases. So what are they looking for, what are their expectations, and how can I tailor this so it resonates with them. And that's when you have that conversation you want this e-portfolio to be professional; do you want it to be personal; or do you want it to be a hybrid of both? So then, you also have conversations about do you want it to be a highlight reel. Or do you want it to be one that shows significant learning. And that really depends on the students.”

Mary, who is a teaching-focused faculty member in an R2 university, shared her experience of making decisions about implementing the ideas she got after attending a KEEN workshop. She described the scale of impact involved, especially at the relatively large size of her university:

“The program director and I talked about different ways that we can discuss assignments to give assignment instructions at different milestones that students

have to meet along the way. It's a two-semester senior design course sequence. And there's a lot of components to this program: in the fall-spring sequence, there's typically about 105 and 110 students in that which equates to about 20-22 teams. And then our spring-fall sequence, there's typically around 60 students or so, so there's 12-15 teams in that. So at any given time, we have 30 plus senior design teams going. So it's a big program. So anytime we make any sort of change, it's just a waterfall effect. There's just cascades throughout. So we can't just change things on the fly without making a big mess. [...]

“And we came back to this idea of, you know, how do we reframe the students’ thinking into a more professional setting with making the connections, the communication, all of those different aspects, and that idea of bringing value to the project—how do we do this? And one of the ways was just incorporating a combination of reflection and discussion. So we have them do these discussion posts; they answer a question, and that's the reflection aspect of it. But then they also have to respond to at least a couple of different people in the class. And we broke these discussion groups down to like cohorts of 20-25 something like that ... I think it was 20 ... and then we had (so this was in the first semester) ... and then we would have a second semester sort of be the moderator for those discussions. So you had a little bit of a mentor in there, if you will. And the students seem to really like that. They enjoyed having that interaction with each other and they enjoyed just hearing other people's perspectives. I'm thinking one of the questions you might have as, “Well, did it make a difference in anything?” I don't know. I don't know if it did or not. We don't have enough data right now.”

Overall, faculty participants tended to report the scale involved in making decisions to integrate the EM across the curriculum. They did not seem to view the barrier of scale, however, as a constraint (Finding II) in their effort, and they seemed to build collaborations within their institutions to move their initiatives.

Context II: The COVID-context

In the COVID-context, making decisions took the form of deciding whether to adapt by trying to remodel the pre-pandemic course offering as much as possible or by trying new approaches. Griffin described the structure of the senior capstone course that he is

coordinating at his large research university, and the grading associated with it, and the extent to which the pandemic affected the assessment process:

“Yeah, so the course is actually structured so that not getting your project built and tested does affect your grade a little bit, but not as much as you might expect. So it's not unusual, you know, even pre-pandemic for students to come to the showcase with a project that shows promise, and if they had another two or three weeks, where they could put in 80 hours per week, they would actually get it done and tested to the point where the industrial partner would be very happy with it. But because we have a hard deadline, you know, the showcase is the end of their work. I mean actually at that point, their final report is turned in. So that's the end. So the course is actually structured so that, at the end you lose some points if your project is not tested, completed and tests, but don't lose that many. And so from that perspective, the students not being able to finish their projects was not that big a deal. And we also were somewhat more lenient, in the sense that we tended to be more generous with points than we probably otherwise would have been, particularly for teams where it was clear that there just wasn't anything they could have done differently than what they did. There were some teams, where it looked to me, and to some of the other instructors, that they just sort of folded when they might have been able to do something better. And we were less lenient there, but we were still pretty lenient, you know, because we also were seeing sort of firsthand ... we're getting reports from some of the students about how the pandemic was affecting their lives, you know, people whose housing had become uncertain or people who, you know, someone in their household, they were still employed, but someone in their household had lost a job, so they had to try to increase their hours to maintain the household income. And there was ... there were just a lot of stuff going on, and so we were probably more lenient than, well, I'm sure we were more than we otherwise would have been.”

The issue of making decision about “leniency” was also present in Vagih’s response:

“Well, we made things optional. So like nobody was forced to do any of that. They can pick and choose. And also, we had a very lenient policy. We basically had no late days. They could turn things in and basically anytime and still get full marks. So we didn't really have a late policy. Based on the students’ situation, we waved a lot of assignments. So like we basically didn't have a very strict grading policies. So I think the students like we're pretty easygoing about the new activities because they were not designed to affect them and their grades in any material way.”

Despite the pandemic, Vagish also described continuous efforts for planning to improve the offering of the course he co-taught with another faculty and adding new content:

“I think we started planning for it ... so I’d say like around July, late July-early August. We met maybe like three weeks or two weeks before the class. It’s a class that’s designed to teach them basically they make prototypes that tell stories through it. So they learn about ... they do ... it’s a writing class actually in our department. So they do writing, but they also do ... they make stuff. So they use 3D-software. They learn a little bit of Python programming. They learn about graphics and renderings, animation software. We have video assignments like make a movie, make a video. It’s a mix of different things where at the end, they learn about science fiction and storytelling. A lot of focus on reading science fiction novels, short stories, and so on. Yeah so we met, I guess, in the early August to start to plan our activities because we knew that we were going to be online for fall lecture. Well, actually, we at first didn’t thought we were going to be hybrid where we’d have to bring in half the class and we’d have to alternate teaching. And we were trying to figure all that out, and then eventually the classes ended being so big that they had the university decided it was going to be fully virtual. But we wanted to have some students have some in person physical experiences for those who felt comfortable and so that’s how we started thinking about it.”

Some of the decisions Vanish and his colleague had to made were around finding available resources for the students to be able to continue working on their projects despite the pandemic:

“Yeah. So we did something where I made sure that everything that was accessible was free, available, accessible, online. So even some tools that we used to use before that required a license, I found a free alternative that they could use without a license. And yeah so we did that and we basically structured it in a way that if they couldn’t get access to something, for whatever reason, they could turn an alternative assignments or so on so forth. But, yeah, we made it so they pretty much didn’t need to use anything from the university physically. We could have gotten some licenses from the university, but it would have been a pain for 100 students managing that. So we just decided to make everything open source that way.”

Sophie showed an interesting ability of making decisions during the pandemic.

Sophie was just hired as a lead instructor of the first-year engineering course in her large research university:

“So I'm the lead instructor. I am the top of the pyramid. For the faculty that we did hire to teach the other lecture sections, they were all identical based on the curriculum I developed. And we hand-selected the ones that we knew would be good with first-year students and that were generally really good at teaching. And that we make sure that was a priority for our first years. The TA's, we also went through TA application process but, for the most part, yeah, they were excited. Some of them are further along in their PhDs would make it a little more complicated as far as their interest ... in like not their interests ... but their responsibilities so that's something we may change in the future is trying to get first- and second-year PhD students to be TA's as opposed to third- and fourth-year.”

Self-efficacy in planning did not mean that faculty participants always attained positive results. Xavier, who teaches in an R2 university, described the challenges he faced in enabling interactions between students for the activities he planned:

“Yeah, the main challenge was I planned a lot of group activities. So, all my activities were around having the students debating and brainstorming, presenting to themselves. So evolving their products independently and having some sessions where we're just in a classroom discussing pros and cons of each product. And I planned all that from the beginning. So, actually it was a sequential activity where they collect lessons from previous discussion, and then they evolve the products as discussions continue with the team. Then, when we moved online, I tried to do that in Zoom but it wasn't very successful. Some students were in different time zones. Some of them even went abroad. So it was very hard to synchronize everyone. And we had like asynchronous and synchronous modalities. So it was challenging. So at the end, I decided to let them do it independently, like discussing your themes at your own time, where there were no space for class discussion as a whole, which I was planning. And also I was planning for them to, as I mentioned before, to go to the machine shops, to go to the labs that we have on campus, and to actually use those capabilities into their projects, but that couldn't happen, because all the labs were closed during that time. And I was asking for a lot of physical meetings. My plan was actually forced them to go and meet with local ... let's say groups or advocacy or whatever ... and take pictures. I like to make them take pictures of themselves when they go to these meetings, just to confirm that they went out in the field. But that didn't happen. Yeah so yeah it was challenging.”

Overall, faculty participants in both contexts showed similar self-efficacy in planning (Finding I) and did not see the contexts they were in to be constraining to their efforts even though the reported lack of clarity of the COVID-context (Finding II). In the EM-context, specifically, the reported lack of clarity in the quantitative phase (Finding I), which was not significantly different from the COVID-context, could be attributed to the large scale involved of integrating the EM across the curriculum, and the notion that just being inspired by ideas from the KEEN workshops may not be enough to actually implement the curricular change.

2.2 Developing a systematic process for change

Context I: The EM-context

In the EM-context, planning for change took the form of a systematic process as well as fine-tuning techniques for faculty participants. Kaleb described the combination of his approach as follows:

“Both. All. I mean there's the deliberate: “I'm going to try this course ... I'm gonna try this for this next semester” ... and there's also the real-time learning and iteration in the context of what's happening in the course. And I think that also that the design of the course itself, especially those sort of prototypical ones, was often very open. I even taught a version of the course where I introduced ... where I explicitly invited students to say, “This is the course” ... I forget the name of the course; it was probably the longest course name ever ... But it was essentially saying we're going to experiment together about creating a course that then we'll teach ... that I'll teach next semester. So, I mean I think that's one of the virtues of my college because I said I don't know what this course can be, I'm going to try somethings. Which students want to join me in this experimental course? That's actually about the later course. And they're like, “Yeah! Great we'll take this course.” And so that is a very clear example of one that was clearly both. This is going to be able to create a box, but he wants to join me, because I don't know exactly how we're going to structure this, and we're going to figure out the best way to structure this together.”

For Connor, who teaches in a teaching-focused university, he was aware of the systematic process of integration; yet, he found it insufficient for his purposes of adding more EM context to his classes:

“In my own development of this course, I have been stepping away from that approach. That approach in my mind is very process-oriented on the technical skill set; it does not emphasize in any way context, or what EML would say is mindset. And my own interpretation of how this course can proceed, it's the application of engineering statics towards solving a problem. Only towards solving a problem that ... and I'm going to just borrow language that [researchers] would posit as applying a problem to create a technological solution, but it's one that is geared for a solution that takes into account broader context of study economics, the environment, culture and history. Those are the ones that I typically hit on. So, this project ... I'll start to describe the project I developed: It firstly arose before I was aware of EML. Before I was aware of EML, this project asked students to design a truss bridge for a community that had been subjected to a natural disaster; pedestrian bridges had been washed out so there was a real world need to fictitiously design new pedestrian bridges, and we make them out of trust structures because that's what they're learning.”

Connor described the challenges of coordinating an implementation of change across different courses. He also described his systematic process of planning as follows:

“Broadly I've been trying to integrate into most of my courses, I have ... I can say this with some confidence ... There are some courses at my institution, where I have more liberty to change things as I see fit. There are other courses where it is more so on ... it's not a committee but it is a highly coordinated course among separate sections, so all instructors must agree. Typically those courses are already established so it's more difficult for me to make a change. So the course I'm describing is one that I have more liberty to make changes as I see fit.

“For me, my own preference in teaching is to have everything prepared at the onset and to actually make very minimal adjustments so the course can proceed as planned, with very minimal adjustments. As I'm learning techniques or approaches that I will have to consider, I'm in a very disorganized way, jotting down ideas, I'm sending myself emails and just categorizing them, I'll have a post-it note here and there. And it isn't until maybe a month before the course is about to launch that I begin to recall and assemble together maybe not a refinement of materials, but to create new materials that heavily borrow from what's already been developed by myself, with a new framework or a new idea at its central core. If that helps; that's indicative of me not having settled ... I can say that ... I'm not settled on materials; I'm sort of so

continually reinventing, sometimes refining, but it's reinventing, with a lot of borrowing.”

For Miles, who also teaches in a teaching-focused institution, described how he was already doing some of the EM ideas, but the KEEN workshops made him more intentional about it:

“And so, for me, I was doing a lot of ... I was already doing many of those things before I came into the entrepreneurial mindset framework. But I will say I'm a bit more intentional about it now given all the things that we've kind of been introduced to about the entrepreneurial mindset.”

Similarly, Mary reported an earlier interest in some aspects of the EM framework.

She provides an interesting insight on the level of impact that the KEEN workshops had on her teaching:

“No, I've been doing that before. I was pretty much an early adopter of the flipped classroom because I don't want to listen to myself drone on for an hour. And I'm sure my students don't want to listen to me drone on for an hour. So, I love that idea, and especially with communication I think it's so important for them to have that interaction with each other, because that's what they're going to have to do on the job. So I want to use class time for that. So, KEEN had no impact on that. I don't say it KEEN did not have an impact on my process for developing classes or class activities, either, because before I even went to the KEEN conference, I took a course in online learning and one of the things I learned about was backwards design. So I start with, you know, the big overall objective for the class, move down to the learning objectives, think about the materials that I need to have in class to help students learn those objectives or achieve those objectives, and then what kind of activities will I use to assess those learning objectives. So where KEEN came into play ... and keep in mind this was just like one-, two- or three-day workshop, whatever it was ... so where that came into play was ... I can't think of specifics, but it implanted in me a mindset of, especially in my professional engineering communication class, what types of activities can I have students do that will reinforce that spirit of innovation, or try to spark that spirit of innovation, and getting them think about making connections with each other, making connections with material, showing how all those things they learned as an undergrad, or all those things they're learning in their other graduate courses, how that's actually going to apply out there in the real world beyond just a technical sense.

“It probably got me even more excited about using case studies, and broadening my idea of case studies, showing what successful innovation looks like and why it works and studying that a little bit more, because, again, I do that from a communications perspective, but also an ethics perspective, so both of my graduate courses qualify for what's called the advanced responsible conduct of research requirements, because we receive federal funding. I teach ethics in those classes. One is more from an industrial perspective and the other is more from a research perspective. But I would say that that idea of value I also try to put an ethical spin on that. So I would say that's kind of a long winded answer of saying that's really working; KEEN has some sort of an impact on me.”

Interestingly, some of the examples explained why teaching-focused faculty showed no overall significant correlation with attitude toward context (Finding IV). The relative difference between faculty participants' approaches for planning, whether it was systematic or fine-tuning, could be observed in the different responses.

Context II: The COVID-context

In the COVID-context, the process of planning was highly correlated with the pandemic situation (Finding I). Consider the following response provided by Griffin, illustrating a careful approach to working out the details of coordinating the capstone design course with industry partners:

“We figured out pretty quickly at the beginning of the summer ... I mean it became pretty clear when the numbers kept going up like you know just higher and higher that we weren't going to be able to make it work face-to-face. And so, as we were recruiting projects, it became pretty clear that what we needed to do was tell the industry partners, “The forum is going to be virtual. You'll have an opportunity to present your projects. You have some slides, some PowerPoints or things like that. And then we'll open it up for question and answers.” And it took a while to work out specifics, like how much time everybody had, and how we were going to get 50 project presentations done. So it took a while to work out the details, but by then, the industrial partners were pretty used to doing things virtually and I don't feel like there ... other than us working out some of the details of how many meetings we're going to have, when the meeting starts, how do we do stuff like that, how do we get the information to students who couldn't attend the meetings ... Things like that ...

I feel like everybody pretty much by that point, by the time we did this in August, everybody was kind of used to do stuff virtually and that worked pretty smoothly.”

As suggested by Griffin, the overall impact on the pandemic, on all stakeholders, may have lowered the attitude of faculty participants toward *constraints*. Sophie, who leads the coordination of the freshman course on her campus, also reported a deliberate planning process to provide the engineering design experience to the freshman in her class:

“Yeah so once the modules were set ... so by modules I mean we try to cover most of the engineering majors that our university offers. So, the first one we did a K’nex bridge; the second module was solid liquid extraction using coffee, so chemical engineering; then we moved into Arduino; and then we moved into a mousetrap racecar. So those are the different modules that we had that had hands-on aspects. The first one with the K’nex is trying to figure out they’re still going to do it in a group and try to figure out how do we get a group to work together to build a bridge when they’re all around the world. So what we did is we mailed them ... what we also have to realize with the kits that we weren’t getting them back; that we weren’t going to ... we didn’t have the budget to have them returned to us. So everything had to be ... just we had to be okay with it being gone. So, we sent a sample of K’nex pieces, so they could see how they connected together and how they worked, and the groups had to then create a design that came back to us, and, unfortunately, the TA’s and myself had to build all 50 bridges. It was a lot. That was probably an example of something that it worked because it had to work in the situation we were in, but that is not a sustainable way of running this. So that will never come back again as far as the TA’s building bridges, unless we have a similar situation.”

For Vagish, planning for change seemed to be more a fine-tuning effort, changing the modality of deliver of his content where he resorted to the Learning Management System that he only used once before:

“I had to use Canvas this time, and I used Canvas once before but definitely was not used to it that much, compared to the older Blackboard, and not used to how to use Canvas like to uploading videos and tribes and stuff like that. So that I did go to this technology center office hours, maybe once or twice max, to really figure out how to record a lecture and upload it and what were the ways to do it, and then understanding a little bit about Canvas to make things. Yeah, that’s primarily what I used.”

Tanner, who is a teaching-focused faculty in a large research university, also reported a fine-tuning technique to his planning for teaching during the pandemic. Yet, he pointed to a challenge he had to deal with around cheating and academic integrity:

“Well, the theory is the same. Every time I go through, I use PowerPoints. I going to find them, change the wording, rearrange, maybe add one more page, but it's still the content, the core content is the same. Now I don't reuse homework. I don't reuse exams. And I create my own questions. I could get inspired looking a problem in a textbook but I modified a lot. So why do I do that? In part because I know solution manuals are everywhere. We got issues when this COVID started with cheating. People tried to outsmart us, outsmart the instructor. We tried to be considerate. Remember this happened right before the break [...] Some of them left on vacation and couldn't come back. So they got an exam a couple of weeks after the break. And so what do we do now? Different time zones. We had to adjust. Okay, let's give them the exam for 14 hours. They could take it whenever they wanted for those 14 hours. Well, that was a big mistake. That was the first thing we learned.”

Overall, in the COVID-context, the process of planning for change was highly correlated with the pandemic situation (Finding I). At the same time, faculty participants in both the EM-context and the COVID-context showed similar patterns of both a systematic process for change and fine-tuning techniques.

2.3 Dedicating time and effort for change

Context I: The EM-context

This subtheme is different from the slightly similar them of “allocating time and dedicating effort” under “*willingness for planning*” in that it shows evidence of *actual* time and effort by faculty participants as part of planning for change. In the EM-context, dedicating time and effort showed as building on previous experiences that faculty had, in addition to KEEN, highlighting an effort that was in concert with previous efforts. Consider Brooke's response,

who is a full professor in a large research university with established record of publications on the topic:

“So I have spent a lot of time in the last ... I would say the 12, or 12 or 13 years really thinking about how to engage students and open into design problems. So I would say that I have kind of integrated, and adapted, and up to fairly radical ways, including design, again very open-ended, client-based design, into undergraduate courses, including courses for which a single project is the entire course and there's no homework, just the one project.”

Brooke provided her views on the KEEN approach to introducing EM, which highlighted the level of effort dedication she put behind the KEEN initiative on her campus:

“Well, I want to say is that I don't ... I very rarely use the term entrepreneurial mindset [...]. There are many words in the entrepreneurial mindset that I can get behind, like curiosity, or value, or design ... like those words resonate with me, and those are things that I incorporate into my courses, but strictly something called the “entrepreneurial mindset” I don't like those two words together; don't really mean much to me.”

Brooke's response resonated with Alex's, who is a teaching-focused faculty in a large research university. Alex explained that they have been already doing much of that work on their campus previously, and that they are actually transmitting to KEEN as opposed to receiving ideas from them so that they would put time and effort into them:

“I think, to my actually original point when you first contacted me, [we] are already doing a lot of that in our work and in our coursework. And, actually, being part of KEEN didn't in any way, shape or form change what we're doing. What we are actually doing, as part of our involvement, is trying to share what we're doing with KEEN.

So we're actually transmitting the other way and we're trying to share and produce material, produce video lectures, and course material, and resources that KEEN can build into it, you know, it's the library of stuff to share with other universities.

And an example of that, I'll give you, is in my world and the clinical biomedical engineering world. There's this thing called needs finding. It probably translates to other places as well, I'm sure. And needs finding being, you know, essentially finding

worthwhile real-world problems that need to be addressed. And that's a subject that I know universities all over the country and world desperately want to get better at. There's two or three universities in the world that are really damn good at it and one of them is us so we're trying to produce material for KEEN to disseminate to those other people who say, "please can you show us how to do this.""

Alex's response highlights self-efficacy in transmitting content to KEEN without being affected by it. That, however, does not negate the impact that KEEN workshops had on faculty participants, which often was related to previous experiences of faculty. Consider Kaleb's insight:

"I mean certainly I leveraged my experience and knowledge from a design perspective because certainly there is an overlap between those. And I think in that, it's everything: It's books, its people, its relationships I've had historically, it's other professors. I think early on, sort of before deploying this course, and sort of the first, and this way I also experimented with the course itself. So taught a version of the course that was for a number of semesters and also taught some of those with different people, with entrepreneurs or people who live more squarely in the explicit entrepreneurial space. And so I learned a lot from that. So I learned, I co-taught the course with one of the entrepreneurs for a period of time and learned a lot from him. And he said, "Well, you know, maybe for this next iteration, maybe we can learn from this person over there who engaged in this type of work in an industry context and was the driver for product and different sources.

"And then I should also say, early on, even in the earliest version of the course in this form, our teaching team was half sort of traditional faculty and half entrepreneurs. And so through that co-teaching, we've learned a ton. Okay, what do you do, how do you think about this, and what books do you look at, and then on top of that, I mean, you just every book you can encounter, everything you sort of start to read to get a sense of okay this is model canvas generation or okay what is Steve Blank is saying, okay there's a lean startup, what do I learn from that. And on top of that then certainly emerge connections with ventures organizations. And, actually, I first encountered folks from KEEN at a venture meeting and started having conversations with them. And even those relationships spawned a lot of sort of learning as well. And so, certainly, when I mention people, I also have to invoke at the very least those two: the keen network as well as venture organizations as being a mechanism for me meeting folks and engaging deeply with people who had similar interests and leveraging the best of what they're doing."

As for the impact of KEEN, specifically, Kaleb elaborated as follows:

“Oh, certainly, I mean that absolutely influenced what it is, what I was able to do, and what I taught that subsequent semester. And then ... I have to go back and imagine think about some of the exact chaining ... but then that course unto itself was an experiment. So there was one experiment at a higher level of abstraction, “So what is the course going to be,” but let's do let's learn that by actually engaging in the course. And then, of course I taught the actual course which was an experiment as well because all of these preceded the course that was launched in its first sort of quote unquote full version, which was the team-taught course. But even, I say, leading to that course, I did work over our summer saying it was a handful of us, maybe six or so of us faculty ... “We're going to spend one week over the summer, one or two weeks, maybe over the summer ... two weeks explicitly dedicated to creating this course, and the way we're going to create this course is by way of these methods that we're teaching, so the same way we have the students do these two week experiments that was our two-week experiment, using the same practices that we're trying to teach our students, even to the point of there were research students over the summer and we had to set up appointments with them to actually deliver some of the elements of the course that we've created to test them out the same way, like we think we're creating value with this course, will okay let's prove it—let's go put this thing in front of students and have them react to it and then use that as feedback into our own process.”

The varying levels of impact of KEEN on faculty participants' time and effort dedication can be observed in the varying responses, despite some comments like Alex's when he mentioned that, “the students are even further removed from it. They don't see any of it, I would say. You know, we as faculty that do understand what it is.” This may help in explaining the lack of clarity of EM context (Finding II) despite ongoing efforts to integrating the EM. In addition, the notion that “students are even further removed from it” may also help explaining the lack of significant correlations between teaching-focused faculty reported *self-efficacy* and *willingness* measures with *attitude toward context* measures reported in the quantitative phase (Finding IV).

Context II: The COVID-context

In the COVID-context, dedicating time and effort for change seemed to have been intense prior to the planning for Fall 2020, when faculty knew that the pandemic would extend into the next year. Sophie shared her experience planning for her first-year class:

“Yeah, the whole curriculum development from nothing to an actual course started July first. Classes started at the end of September. So we did all of that knowing that at least the lecture would be virtual. But the lab at my university was pushing be in-person. And then in August the university said, “You know what? The pandemic is really bad; your labs now have to be virtual.” So that's when we still had the modules but then I had to adapt some of those modules to be virtual, such as the bridge—that was the hardest one that I was hoping we would get the first couple weeks in person, and we didn't get anything.”

Tanner commented on the extra time he had to dedicate in order to plan for his classes in the virtual environment:

“Of course, I did. I did I spend the extra time. So it's more time. I mean that time that somebody may argue that nobody was coming to my classroom, right? But during that time I was not coming to campus. If I count the number of hours that I worked, I mean all the additional hours that exceeded my commute time. And I'm saving, oh yeah I'm saving what 45 minutes to a one hour, roundtrip with a parking lot in the walk. I was working much more than that.”

Despite the fact of reported extra time and effort in planning for change during the pandemic, faculty participants did not report any specific constraints as hindering their process of planning (Finding II). Sophie provided the following comment which may help in understanding this finding:

“The students didn't like that it was online, but they understood why it had to be, but they also would say that they appreciated how it was handled: that they got lab kits and that it was interactive. So they recognized the extra effort that went into making it a good course even though it was virtual. They didn't like that it was virtual but they knew they couldn't do anything about it.”

3. Differences in *willingness for adjusting*

The *willingness for adjusting* illustrates the quality of being ready and prepared to modify or alter behavior in order to achieve a desired outcome or in response to change in the environment. This involves (1) **motivation to change oneself behavior** that is associated with persistence and a willingness to bear responsibility; (2) **motivation to change context** through engaging in discourse with others and through social interactions; and (3) the active involvement in seeing and taking advantage of **opportunities**. Faculty participants portrayed varying levels of *willingness for adjusting* in the two contexts of this study.

4.1 Motivation to change oneself behavior

Context I: The EM-context

In the EM-context, the motivation to change oneself behavior was present in virtually all participants' responses and in very emotional and moving ways. Connor, for example, shared how personal to him was providing the social context of engineering, and found that integrating EM in his courses to be one effective way to do that:

“I think for me it's very easy to say that this is a personal motivation. I can share just something very briefly. I can share that my own upbringing is ... very clean with language. My own upbringing informs my position as a member of a non-dominant group in engineering. So because of that I learned over time in my collegiate and postgraduate training that I have a responsibility, or at least I have an opportunity, to help students who are perhaps dominant groups themselves realize that engineering does impact non-dominant groups in ways that are easy to tease out and are very difficult to actually identify and be aware of. I wanted to create, irrespective of the institution, materials that prompted this type of awareness and thinking. My present department supports that. I think I would still be doing this had I been in a different type of department, all be it without support, and perhaps for that success, in accordance to the promotion and tenure outlines.”

The perspective provided by Connor may shed light on Finding V of the quantitative study, about *willingness for adjusting* being not correlated to context. Connor also elaborated on how change in the curriculum should take place, by integrating content into courses and not creating separate courses (for EM, for example), and what success and excitement mean to him:

“The curriculum is a sequence of courses that touch on topical areas. Some might interpret that a curriculum that infuses EM or social justice issues means that there need to be delineated courses that specifically talk about those things. And my response or my feeling toward that is, “No, no. Please don't do that. Students will silo, just like a silo away an ethics course or a history course or Gen Ed course.” They'll say, “Those are the non-engineering classes and in my curriculum these courses that are labeled the ENGR are the engineering courses that matter; everything else is to stop that I'm forced to take for some reason. In my own thinking, should EM manifests itself in the curriculum? No, not in that sense. Should it be integrated across our courses, both in the engineering courses and, ideally, the non-engineering courses outside of engineering? Yes, I think it can manifest itself in different ways: specific assignments, or couching things in a similar language so that students can see those connections being made—yes, I completely believe in that.”

“The one example I want to tease out is the engineering statics course that I'm focusing in on. In my most recent offering of that class, and the reflections we're generating, I was better at couching the assignments in the same language they've seen in their calculus courses, physics courses, and in there earlier first- and second-year engineering courses—focused on design. I couch the language into those courses, and students were saying in their reflections that they were understanding why they were forced to take those other classes. They were seeing how in statics everything was coming together in their reports. That to me was a success because it meant that I was successfully creating something that helped them chip away at these feelings of silos in the curriculum and to realize that good solutions are integrative of engineering and non-engineering ideas. That's me feeling excited; I don't know the students will carry this forward because they're only in their second year and they don't see this every single time. They'll start to see things that are more traditional by faculty who don't care much for integrating; they just want to teach their time.”

“So, in terms of curriculum it sucks because a curriculum is what we hope to achieve at the end of that curriculum. There's ups and downs and I don't think our curriculum is set up ... maybe because of bye-in, maybe I don't know ... that becomes more complicated I guess ... We can keep on and on about this, but ...”

Miles shared his motivation, linking personal goals with professional goals. He explained that without the integration between content and application, he couldn't teach:

“I think it's interesting for me to kind of keep current. So it's a couple things: for me, personally, it's interesting to tie things that I'm teaching to applications and real world events, because if I can't then I actually have a hard time teaching it. So if I stand up there and say, “Well, today we're gonna learn about first-order circuits,” and I can't really give you a good application for it, my heart's not going to be in it when I'm talking about it. But if I can say, “Look, first-order circuits. We're talking about batteries as they charge, discharge. This is important ... and these kinds of things,” like it makes it easier for me to talk about and I think that that honesty and that reality in terms of like, “Hey this topic is really important. You should listen,” transfers to the students and then the students take it in better. So it's not like I'm just talking about a topic because I want to talk about it; I've given them reasons to understand why what I'm talking about is useful and how they might apply it in the future. So it's a two sided thing for me. It's for the students benefit to see the application of it. But it's also for my benefit so I believe what I'm telling them is useful. It's really hard to stand up there and just talk about dry things. At my previous institution, I taught a discrete math course, and like I loved teaching it because it was a fun math course, but when you're doing set theory and things, it's hard to draw applications for computer engineering students. So I feel that I really tried to give them applications, and I think it adds validity to what I'm telling them, because I can say, “Hey, this is where this is used. This is where it might come in handy.”

Ralph shared his motivation to pursue the e-portfolios as a way to integrate the EM in the curriculum on his campus, and how he saw his role as a professor:

“Well, one of the things ... this is actually from a workshop from an instructor at [a university] and she said, based off of one of the people that she's researched, stated that “A transcript and a resume are record of the things you forgot.” And that actually resonates with me. But to see a student, or to see someone be able to take a hold of the narrative of themselves as well as what they have learned and what impacts have motivated them, or have made them do things differently, and be able to express that, in a way in which honors who they are, and who they are becoming, that's powerful to me. And I see my role is not a sage on the stage, but more so, a guide on the side. So how might I be able to help them get to their next level and move barriers out of the way or help them negotiate the barriers that are in front of them? That's what I think the most powerful thing as a professor is this what I can do. I mean, is it teaching them how to use calculus to understand the complexity of dynamics? No. Is it helping them to understand that grain boundaries are the most significant place where interactions occur between material? No. Is it to help them

negotiate life so they might have a positive impact upon the future? Yes. So for me it's how do I do that in a way that helps them improve themselves in the process. More importantly, helps them to be aware of their contacts and be aware of their impact on the outcomes, so that's why I do.”

While all the previous participants came from teaching-focused universities, similar descriptions were shared by faculty participants who came from research-focused universities, which is helping explaining the lack of difference across contexts (Findings I and V). Consider the Xavier’s response and how he sees the links between the EM and conducting research:

“I believe it is very important to complement their skill sets with the EM component because that adds more value to the type of activities that they can produce in the future. And especially because these are research and EM, I believe research endeavors are very aligned with EM because when we do academic research we always do the three C's: basically connections and creating value and curiosity. Because if you are creating something new, you have to have those. However, sometimes that is hard to convey to students. And I think the EM rationale, or the EM path, it's a very nice overlapping that I can instill to my undergraduate students. And, well, again, I believe that adds value to them when they graduate and when they can be independent. So, that is the main reason. And it's fun; I enjoy doing it.”

Vera, who works in an R2 university, shared a similar insight, highlighting the lack of boundaries, in her perspective, between teaching and research (Finding V):

“So I think, when I look at my pathway as a faculty member, I've always really, really valued being able to have both research and teaching, and have them both, and valued in true sense to not just kind of lip service to one. And so that's why I wonder where I am and it's also why I think that, hopefully, I pay a lot of attention to thinking about what goes on in my course and trying to do continuous improvement processes, whether that's KEEN or something else. But really trying to get a good pulse what's going on and what works and what doesn't. And so I think just drive to be a good educator makes me involved in these things and at least thinking about them and at least having goals in mind, even if they don't always come to fruition.”

Overall, the motivation to change oneself behavior in the EM-context showed to take the form of a perfect alignment between personal and professional goals and interests.

In the COVID-context, this same motivation was present, but in the context of the pandemic took a different form.

Context II: The COVID-context

In the COVID-context, motivation to change oneself behavior took the form of persistence and a willingness to bear responsibility. Griffin, faced with the challenges of coordinating the senior capstone design, shared his motivation to *adjust* during the pandemic:

“Because I couldn't figure out a good way to stop! Yeah, I mean ... You know I guess my motivation was to do as good a job as we could do under the circumstances we had. I personally had taught online classes before and I am comfortable enough with technology that I personally did not see doing the virtual version of classes to be that hard. And I suspect that part of that is that I may not really understand what works and what doesn't work in the virtual class. But, you know, to take the lectures online, or to take the lectures onto Zoom, to take the team meetings onto Zoom, to take the presentations onto Zoom, from a logistical standpoint that wasn't ... for me that was not very hard. And so I didn't see that as being really problematic. For me, the harder parts were, you know, sort of the more human issues associated with my own situation in the pandemic, and then also, you know, since both capstone classes are team-based classes, trying to work through some of the teaming issues that the pandemic caused ... meeting virtually doesn't work for a lot of students nearly as well as meeting face-to-face in a team meeting. And, again, the pandemic upended a lot of people's lives in terms of what they're able to do. I found, personally, that there was a growing sense of isolation. I mean, staying at home ... you know, I won't go into all the details, but you know all of a sudden, there were there was a lot of complications due to that. Yeah, there was a growing sense of isolation. I felt in particular very isolated from my colleagues. You know the faculty associates that I taught capstone with, we met occasionally, and that was good, but yeah there was ... So that personally was kind of difficult.”

The human-element was clearly present in Griffin's response. Although he talks about the challenges of delivering courses during the pandemic, because these challenges transcended the into his personal life, that could be a reason why he could not see them as constraints any more (Finding II). Also, he clearly persisted to deliver a quality course

regardless of his attitude toward the context (Finding V). Mary, who is a teaching-focused faculty in an R2 university, shared her motivation to take a course on teaching online before the pandemic, and how this turned to be a valuable experience for her teaching philosophy as a whole:

“Well, the university gave us extra salary for taking the course in the summer, so that's always um ... but also, you know, I have a strong interest in pedagogical research, educational research, so I just wanted to become a better teacher, especially online when there are a lot of challenges. Some students adapt very easily to online learning, some don't. I love the idea of bringing in universal design principles into all of my courses. And I will say what I learned in that class, which was a one credit class, it was actually taught online, it had an impact on all of my teaching, all of my courses, and really helped me improve those and again it helped me mentor other people, too. But those were the two motivations, you know, the university had a little carrot there, but really just wanting to improve.”

Sophie saw the *willingness to adjust* as an expectation, not constrained by anything (Finding II) and as something she has already experienced in her prior life as a doctoral student:

“Yeah I think I have to be. We run quarters; my life changes every 10 weeks. So I have a brand new schedule, I have a brand new wake-up time, every 10 weeks. So I have to be adaptable. And I think being ... coming from ... or so being technically a graduate student, and being in academia this whole time, and funding worries, where am I gonna live, do I have a roommate, I got married in the process like. I think that's trained me to be very adaptable. And I hope I never lose that as I get more advanced in my career because I've seen professors who have lost it, and it gets very frustrating to work with them.”

Vagish, who is a research-focused professor in a large research university, described how he adjusted and his motivation behind it in response to what he described as a “sense of urgency.” He also described personal steps he had to take to purchase technology without referring to his university to provide that technology to him (Finding V):

“Luckily I was mostly slide-based anyway, in both my classes. I would kind of have slide, but I would like to write on the board. And so it just turned into I had to do a

Zoom; that was not bad. But then the big major thing I had to figure out is how to do like writing on the board, and so I actually bought an iPad, personally. I probably could have gotten one from the school, but it would have taken forever and it was a bit of pain, so I just bought one. I bought an iPad; I bought a pen and I figured out how to plug in so that I can write on the slides. Now I can also open a whiteboard and write on the board for the whole class. So that was like the major thing I had to figure out how to do.

“I mean I think there was just like a sense of urgency, especially since it happened in the middle of the semester. There was a lot of we just gotta get to the end of the semester; we got to make this work. And so there's a little bit of that. So it was like mostly necessity, I would say. The only thing that wasn't necessity was maybe that experiential activities and where we actually took some time to be like we want students to have a social interaction. So that was the only ... so the motivation was a lot for the students, like their experience, because I feel I think all of us kind of felt and knew that they were not getting the experience they had really paid for, and stuff like that. It was just not the same, and I think the university was trying to pitch it to students as it's the same, hybrid, it's better and stuff, but it really wasn't. The only thing that was really good was that they maybe could go and watch the lectures asynchronously, but other than that there was no benefits to the hybrid model, and it actually made in-person worse, and it made the online worse. And so enablers ... I think necessity was one; just like had to do it; had to figure out a way to get students connected; had to figure out how to make the assignments able to do; so on.

Varun has specifically described the lack of “oversight” (Finding II) to be an enabler for his motivation to adjust and change his behavior:

“One of enablers, actually honestly this might be a little different from what you referred to is that, there was actually relatively little oversight, and I think it was this general mood that everyone wanted to get through this period, that like, you know, if I wanted to drop something I could just do it, and nobody ... I didn't have to ask anyone. I mean, I really do have to ask permission to do things in classes, but like I felt even more empowered to be like, “Yeah, yeah, just screw it. I don't need to have a final project.” I actually had it written in syllabus of one of my classes in that spring 2020 that there was going to be a final project, and then I was just like, “Yeah, it's not worth it. I'm tired. I don't want to grade it. Students are tired.” And I just cancelled it. Like I effectively gave them all A's in that final project in some sense, because I was just like I don't want to deal with this. So, I guess the necessity. There was a lot of forgiveness on as long as you kept your ship running, nobody complained. And so I took advantage that. Like deadline—one of the enablers is ... I've actually always done this; I've always had a kind of late policy that's relatively lacked, some lose, but now I can really do it without even feeling guilty about it.

There was no real deadlines in this class. The only deadline was get everything in before the final day, kind of thing.”

For Tanner, who is a teaching-focused faculty in a large research university with a significant industry experience, he reported that he did not adjust:

“No, it didn’t change. And I realized that to do a better job I needed to be in the classroom because when this COVID started the first part of that semester, I mean it was in the spring of 2020 right, then no body came to the classroom. So I was doing it remotely. Initially, I was happy. So that's nice; I don't have to drive; I don't have to ... oh that's great. But then I realized that with that, there are many distractions; not for me, but when I was lecturing, I was talking to a monitor. But look for students, I knew students would be probably changing, checking their Instagram, their Facebook, all those. So it was completely inefficient. Summer came and I taught one course in the summer. And those were the rules, it was going to be taught as an online course, so I did it online. And I got a projector where I could write. I got everything I needed. I also had a tablet that I could write and I could do my job. So as far as technology, I had everything to do the job.

“Now, why did I do that? Because I think I needed to have the means to reach the students. Did I reach them? Probably not in the way I wanted [...]”

Tanner decided to continue coming to the classroom, and in his interview, he emphasized that continuing to deliver the course as usual was necessary and a representation of commitment, as he used to do in his experience in industry. Tanner represents a case where a faculty participant reported that he did not adjust, even though in his decision to continue to deliver the course despite the pandemic was a form of adjusting in the sense that he wanted to continue to bear the responsibility.

4.2 Motivation to change the context

Context I: The EM-context

In the EM-context, the motivation to change the context took the form of engaging in social interactions with others to build capacity for change or learn new things and be part of the

change. Brooke, for example, who is a research-focused faculty in a large research university, shared how some participants of the KEEN program tried to improve the way KEEN frames the EM by providing feedback to the organizers:

“Ah, I think it's fairly widely shared. And I think, well, I know that members of the KEEN network have tried to give KEEN that feedback ... given the current foundation that feedback and they have not been receptive.”

Alex, who is a teaching-focused faculty in a large research university, provided a similar insight:

“The things they're not doing ... I mean to me it kind of shows at I-University, they're not reaching 95% of the people that work there, because they're talking in a language that those people either don't understand or find obnoxious. And, you know, the art of marketing is to understand what resonates with your market and make yourself look like that. And they don't; it's kind of like “Our way or the highway. We've decided on this.” And it resonates with 5% of the faculty at I-University and it alienates 95% of the faculty at I-University. And I think that's a shame because, okay, maybe not all of that 95% of people who are going to be useful and help, but some of them are, more than maybe half. So, they've just chosen, in your face, highly-produced, “Here is our message, and you're gonna believe it,” which just turns a lot of people off. I think they failed to understand ... well maybe ... for it looks like they failed to understand the breadth of their market. Maybe they did understand the breadth of their market and they said, “Screw all those people. We're just going to target this niche over here.” Maybe that was a conscious decision, in which case they're doing it really well, but I wish they'd stop with the cool aid. But they are targeting very much at the periphery of a university like I-University, they're not targeting at the heart of it.”

Ralph shared his efforts to engage with others and get feedback on his implementation of the e-portfolios:

“I was doing the e-portfolio piece as part of my class, and I was at a conference, and I met some individuals from [another university] and then they were like you should talk to this person; you should not do that and that's what I did. And then from there, it was, “Hey I know this person in that conference.” Any presentation that was given that resonated with either our effort to scaffold the portfolios, or how to embed them within the structure of your courses, or to the impacts that e-portfolios can have on a micro-, meza- or macro-level, I would go up to the presenter and ask her, same thing you're doing to me, ask them for about 15, 30 minutes of their time

and then explain what I was trying to do, why I thought it was important. And then they would go, “Oh, you might want to talk to this person!” So it's extremely, extremely significant and helpful, because depending on where you are, you can leverage off of what's already been done, which is the bedrock of research, or you can try to reinvent the wheel, which takes you more time. And that cut out a lot of the time in trying to implement something, because people have already tried it and now you get to the point of best practices of “Here's what I've done, you might want to think about this. You might want to think about that.” And you begin to be able to sift through what might work with your student body and then even when you've gone through that you're on refine it anyway, because what may work with that cohort may not work with another. But now you've created those connections, and you have that network, to bounce ideas off each other. So currently, right now, I'm in. two groups that are utilizing stories but one, in particular, was all about how to use the power of story, for it came about how to use the power of story for the use of the e-portfolio. And, and that was a partnership between [two universities].”

Engaging in discourse with others and coordinating efforts was a big component of Vera's effort to integrate the EM in the courses that she taught:

“Primarily talking with people on the KEEN network, and the materials, and the discussions there. And in the case of the lab class when ... I actually am on a rotation and I teach that every other period, and somebody else teaches in another in the off years. And so working with that person has been significant resource. So we've gone back and forth on it and then also I had a graduate student who's now graduated but wanted to get some more teaching experience and so helped out with the lab. And so the three of us really talked through and collaborated on this lab effort. And thinking about, “All right, if we're doing a sequence of all of us teaching it, how can we include that aspect also as a confounding factor, or otherwise in the evaluation? So, what does it look like different, semester to semester, person to person?” So, I guess people has been my biggest resource as opposed to, you know, a tool, or something like that.”

Jack, who is a teaching-focused faculty in a large research university, reported a mentorship relationship with another research-focused faculty where they used to meet regularly to exchange ideas. In Jack's response, one can see that there is a need for support from the administration as their efforts seem to have been in isolation from the curriculum as a whole:

“My colleague in some ways he's been a mentor to me. I haven't seen him since last summer. Last summer we used to meet. We used to have meetings on Saturdays: the three capstone instructors and him. We were trying to see what can we do to improve the course. And one of the things we concluded that, if we want to implement EM we need support. [...] This is not the first time I've said it: if we want to implement EM, we need support from the administration. And the support is not with a projector, [...] Now, I modified my syllabus to add some EM, for my Practice of Engineering course and capstone. In part I modified because it was part of the EM initiative, right? And I put it in the syllabus, the objectives, EM objectives, EM 2.0. But am I required to do it? No. I'm not the only person who teaches capstone. I'm not the only person who teaches the Practice of Engineering class. I do it because I see value. . Everything I try to create has EM. Am I required to do that? No. I said it's in my syllabus. Okay. But I'm not required. So in order to start incorporating officially EM, we need the backing or the support or the pressure, if you want to call it, from the administrator, that you are going to do it. Whether you like it or not, you're going to do it.”

The comment by Jack alludes to the issue of *attitude toward the clarity* of context, where there is no support from the administration, as well as the *attitude toward constraints*, where he was not required to do the implementation (Finding II). At the same time, it clearly shows the *willingness for adjusting* regardless of the context (Finding V).

Context II: The COVID-context

In the COVID-context, and in the motivation to change the context, the lack of social interaction during the pandemic had its influence on faculty's ability to change (Finding I on the high correlation between *willingness to adjust* and *attitude toward context*). Consider Griffin comment comparing his behavior before and during the pandemic:

“No. Well, I tend, even before the pandemic, I tend to not be very social, and so I try to get my work done and talk to the people I need to talk to get my stuff done, and to help them get their stuff done if they need it, but I don't necessarily go out of my way to just go say “Hi” to people. The pandemic greatly exacerbated that. And so I felt for the most part, like ... I mean, really if you were to ask me what most of my colleagues did during the pandemic, for most couldn't say much. The one exception to that was when a faculty colleague during meetings, she was very good about just

you know letting people kind of talk and get stuff off their chest and stuff like that. That was helpful. Yeah I think one of the real issues that the pandemic caused for me was a sense of isolation. And, given the work that I have to do [for the administration], that sense of isolation, I think, made [that work] harder because of, you know, to put together these self-study reports, I had to get a whole lot of information from people. We have to do continuous improvement processes and stuff like that, and I remember the first continuous improvement meetings we did in April of 2020 it was so nice to actually see people that I usually don't even ... it was just nice to see people on the faculty. But yeah so for me it was ... I think one of the real struggles and I think what contributed to the sense of exhaustion was just that, you know, I felt very isolated. I felt like I was doing what I did in a very, you know, almost a vacuum.”

The missing human element of communication during the pandemic proved to be a significant element in Griffin’s case. In contrast, the community in Vera’s university managed to come together to discuss ways to improve teaching during the pandemic:

“We have our coordinator reach out and say, “Hey, do you want to do this?” And then I guess it's not really an enabler but kind of a motivation for as, again, desire to improve in the classroom, and in the setting I’m in, many of our faculty do care very, very deeply about their teaching and how to improve it. And so those discussions through the community of practice I think opened my eyes to how things can be different and better, and so they, in some sense, also enable or push or facilitate working in that direction.”

Mary shared her effort to help other faculty’s during the pandemic, building on her experience in online teaching prior to the pandemic:

“Well, I had ... it started with one faculty member who knew that I had experience in teaching online. So he came to me and was basically, “Help!” Had some conversations with him that went well, and then I just thought, “Well, maybe other people out there need help,” so I sent an email to the department. I had faculty come and ask me how to use certain types of technology, everything from which type of document camera I use, to what my web cameras like ... (which my webcam is actually about ready to die because it was flickering on there, it just did it ... I got a new one coming in the mail ... because I use that a lot) ... And then some classroom techniques, too. And then lots of emails, just you know, email questions, “Hey have you tried this? Or what do you suggest for that?”

It's insightful to compare both Vera and Mary's response to Vagish's., For Vagish, who is a research-focused professor in a large research university, he laughed when asked about social interactions for faculty to support one another during the pandemic:

“No ... I'm kind of laughing because I think that would be ridiculous ... like that would be funny because the department has no incentive to make teaching good in that way, I feel like, at least at our schools. Yeah, I think they care more about the numbers and how all the numbers are doing, so.”

Despite the challenges of the pandemic, overall faculty reported available support from their universities; there were no constraints in that regard (Finding II). Tanner, for example, reported that, for any suggestions during the pandemic, “No, no, my department would have supported.” Similarly, Mary reported the following:

“I would have to say that my university was incredibly supportive. We have a phenomenal center for teaching and learning, with the bulk of their responsibility for helping faculty get the technology they need, get access to software, different teaching tools, different techniques. They helped sponsor some teaching and learning sessions. They were fantastic. There are no faculty on this campus who could complain that they didn't have the support they needed. They may have needed more time, a lot more time, but nobody can help you with that. But yeah I would say our center for teaching and learning was just phenomenal.”

Overall, despite the challenges of changing the context during the pandemic, and the limited human-to-human interactions, faculty reported available support when needed and no constraints in that regard (Finding II); yet, the heavy impact on the human aspect of faculty participants' personal lives, and its subsequent impact on their teaching, was also prominent (Finding I).

4.3 Taking advantage of opportunities

Context I: The EM-context

In the EM-context, taking advantage of opportunities took the form of experimenting in a new project. Consider, for example, how Jack, who is a teaching-focused faculty in a large research university, described how he took advantage of the opportunity of the KEEN activities on his campus. For Jack, KEEN resources enabled him to reframe what he has already been doing:

“Before, I said you need to solve the problem. Somebody who's going to get the benefit. Somebody needs your solution. And that's what I stopped, but now I reinforce it. And, you know, there are some nice videos about EM and what we do. I go to the website, download them. The three C's. You probably have seen this, with these fresh graduates who made batteries. I mean I showed them, right? So I present them in my classes. I don't do that in theory-focused, 200-level because they don't have ... In theory-focused, 200-level, when I go into power plants, the last part of the course ... so I say now we are powerplant owners; we want to get more benefit from our investment. What can we do? So we discover that we need to do something better, with some discovery. So I say, “Look, we're trying to make a connection.” You make the connection. Sometimes in some semester I have shown them the video ... the eight minute video ... at least give them something. But I cannot afford the time to do that. So I go through the process and say let's improve this, let's improve this. Of course, it's only a very short part of the course, near the end of the course. And they see how I'm applying the process, from identifying what could be better and why, to understanding what controls that thing that we could make it better to make it better, at least on the paper ... on a piece of paper. And that's what I do with my theory-focused, 200-level.”

For Jack, however, taking advantage of this opportunity was not related to the financial incentives associated with it, even though he appreciated it:

“So we need a structure, but it has to be done because of the buying of the people who do this. And the incentive, at least in my opinion, it's not money. I bought in, you know, I got a few thousand dollars for the whole year. That was good; I don't reject it. But the motivation has to be to acquire the tools to do something better. People are going to do it because they want, not because of the reward. And the reward, I mean, selfish, right? I was able to make my students create this. Maybe that's ... and nobody will recognize it, but you know ... you as a faculty you have seen that transformation of the student going from day one in the capstone, where they are lost, they don't know where to start, until you start coaching, directing them, at times become a mentor. And you see the product. That is very rewarding.”

Taking advantage of the opportunity afforded by KEEN also took the form of the need to improve one's teaching. Miles elaborated on this as being part of the expectation of his position:

“No, we're supported in that. So my university is a largely undergraduate institution. We do have a couple of graduate programs, but we are primary undergraduate institutions. So I think there's an expectation that I'm always improving my methods, tweaking them, trying new things. If I wasn't, I think that would be looked down upon. So I am given permission and encouraged to do these things. Now it's not like I get a week off every year to do this, but, yes, there's administrative departmental support. And also, I mean, it's part of our promotion and tenure evaluations, like you're gonna be asked what have you done new? What have you done different? How effective was it? So I am incentivized on multiple levels to do these things..”

Overall, in the EM-context, the opportunity in engaging in change associated with KEEN took the forms of gaining financial incentive, improving teaching as part of the expectation of the position, and a desire to create a meaningful experience to the students.

Context II: The COVID-context

In the COVID-context, taking advantage of the opportunity afforded by teaching during the pandemic took the form of experimenting in new pedagogies. Consider Xavier's comments on how teaching in the pandemic forced him to try new things:

“Yeah COVID forced me to actually do it, yeah. For example, making exams specific to every student, I had that in my mind, but somehow I was pushing it because it's actually challenging—I had to code everything and randomly create variables and stuff like that, so I was like, “Oh it's too much pain. I will just keep doing the regular exams.” But during COVID, because I had to deal with the dishonesty and trying to minimize that opportunity for them to do it, I forced myself and I basically implemented that idea that I had in my mind. But just because it wasn't an urgency before, but in COVID it was, for sure. And now that it's done I will keep doing it ... in my classes.

“So yeah. And I mean ... maybe before, I was more silent online like I didn't send much emails to the students during the semester, because I was speaking everything

in the lecture. But that said, now, I feel that by communicating through emails with my students, and even using chats and things like that, it's more friendly. And some of them actually liked it, and I've seen that in some evaluations like, "I liked to have direct communication with my professor through emails." And I tried to make it friendly .. to be as friendly as I could. And I could notice that by writing things down, the information gets more ingrained in their brains, because when I was speaking in the classroom some students are distracted, and then they'll get the whole information. And sometimes I send like sporadic emails, but now I am sending emails every week, or multiple times a day. I think I will continue with that practice. Yeah."

The idea of being "forced" to do something during the pandemic resonated with Sophie's plans where it worked for her perfectly to try the things she was planning to do:

"Yeah I definitely I mean super willing to do the modifications because it's for the students, and those are the customers. Those are who I'm concerned about. And I wanted to have this the best experience for our students. So, there was never an option of just kind of ... I call it phoning it in ... like we had to do our best. And it ended up working out really well because, like I said, it gave me... it forced me to look at the resources that I didn't know existed, such as Tinkercad, and opened my eyes to a lot of different ways of doing things. So I'm kind of grateful for it." In Sophie's response, it was clear that her *willingness to adjust* was irrespective to the

context of the pandemic; yet, it was a perfect alignment for her to pursue her interests.

Vagish described the opportunity afforded to him in the online environment to invite authors to his class—something he could not "grasp" how to do before:

"Yeah, I think it did. And, you know, because we were online, we could invite authors and stuff like that. I guess we could have done it before but we never, never really grasped how we could use Zoom before COVID. So I think for sure that helped. I think it did cause a little bit of pressure to come up with these activities to keep students engaged, so kind of led to some innovation. That being said, the amount of work required to maintain these activities, I think now that we're going back to in-person, we probably won't do them like. We probably will just go back to ... the easiest way to have students interact is face-to-face, in-person, and small groups in the classroom. And, you know, it's more because it's minimal effort on my part that I would probably default back to that. I don't think I would maintain the same amount of energy, both in terms of teaching and research advising. There's a lot more overhead of just doing online than in-person."

For Tanner, teaching the pandemic, with the availability of the technology, allowed him to record lectures—something that was difficult for him before:

“Oh so, for example, that I could use Zoom sometimes to record an excellent lecture. Or maybe you I need to present something else that I wish I had the time in class to do it and I didn't, so I record something 15-20 minutes that if they want to access and watch it, they watch it. So that's something new which before I didn't do that. Well before if I had to do that, I got to go to “the building.” They had the projector there and I will present this thing, record maybe a solution to a problem, or something. The courses are very heavy in content. So I cannot spend too much time doing applications. I cannot. [...] But Zoom is something that I value, because it can be used to transfer knowledge provided that the other wants to receive it.”

Overall, for faculty participants in the context of COVID, the pandemic allowed them to experiment with new ideas, many of which were things in the back of their heads but did not have the time to fully implement them; the pandemic context enabled them to do so.

4. Differences in *self-efficacy in adjusting*

The *self-efficacy in adjusting* illustrates the quality of effectively being able to modify or alter behavior in order to achieve a desired outcome or in response to change in the environment. This involves (1) the **development and implementation** of curricular change while balancing competing values; (2) being involved in **coordination** efforts to discuss, evaluate and support curricular change efforts; and (3) displaying **awareness** of what is involved in curricular change, in terms ownership of both autonomy and accountability, as well as in terms of what others are doing during change. Faculty participants portrayed varying levels of *self-efficacy in adjusting* in the two contexts of this study.

5.1 Development and implementation of curricular change

Context I: The EM-context

In the EM-context, the development and implementation of curricular change was related to the careful consideration of language associated with the implemented change. Connor shared how that was important in his implementation for change:

“Yes, and I can unpack that just a little bit more. Where I had tried this before, without the EML framework, and I’m gonna pick on “creation of value” that that’s really the verb that helped me, I would have students undertake this course of action and ask them to consider these different contexts to inform their design. And because these were second year students, they had already seen some of the human-centered design process, so they were very good at crafting very ... and I will put some words on to this ... creative or innovative solutions that were very technically worked. They resisted trying to incorporate other factors in their engineering design solutions base. It wasn’t until I started using the language of “creating value for community,” where a community would be more receptive toward a technical idea, that students began to actually integrate those disparate ideas into their design. That’s where I saw value in being able to use that specific framing of the problems.”

For Ralph, there was a need to carefully select a set of prompts to engage the students with the e-portfolio activity:

“So the portfolio for me is that place where the students can really develop their entrepreneurial mindset because they’re looking at potentially a project that they’ve done in another class. And, with the right set of prompts, you can begin to elicit what did they learn; what was an epic, a fail. And it’s okay if it was an epic fail because you’ve learned something. You’ve learned to possibly think differently. You’ve learned to possibly act differently. Or you’ve learned to place things in a different sequence that would traditionally be considered not right but in the case of the context of what’s going on it made the most sense, and had a powerful positive impact. That process of evidence-reflection or artifact-reflection and then creating a portfolio with these rich stories allows our students make those connections, not just to the three C’s of curiosity, connections, and creating value, but it also allows them to tell their story on their own terms.”

Jack described how his implementation of the EM takes place in one class in his course, with the expectation that this would prepare the students to utilize the idea presented in that class in their capstone design course:

“When I do “Practice of Engineering” [the course], I spend one lecture doing EM. And in my “Practice of Engineering course,” I break the class in groups of students. I used to have before 45 students, then they started increasing, making 50. Now, we are at 70. And what I want is the students to work on a project, because the way I see this course scores is it prepares them for the capstone, because some has project management, has engineering ethics, has intellectual property, and has the mindset of why do we do that. So I have some liberty to put the topics there, so I put on EM there. So they have one class. And I know because initially I had no clue, right? So I invited a colleague who came to my class. So I saw how he did it. Very convincing. Of course, he's very ... the way he lectures is very amenable. It's not dry, so get the attention of the class. So I try, I try. So, I spent one lecture doing that, and then I say, your project ... and I don't pick a project for them ... they have to select a project, something that they have curiosity, or they would like to see something that doesn't exist, they went to create it ... or maybe already exists, but has some things they don't like. And they go through the process of discovering as a team, brainstorming, because you see the right personalities in the teams and some of them are struggling, they want their ideas to prevail. They go through all of those things. At the end after three weeks, they come up with the project definition: this is what we want to do.”

Jack described how he invited a colleague who was able to deliver the content in an engaging way. In Kaleb's case, he related the process used in his university to implement change:

“Right, so in here we leverage sort of agile processes ... I don't know if you're familiar with things like ‘scrum’ ... and so will say, “You have a two-week sprint, or a two-week experiment,” where we don't leverage scrum. We actually have them engage in these two-week work cycles that are self-contained and we say, “Okay, over the course of these two weeks, you need to put some artifact deliver some value that you think you can in front of a potential user customer and get some feedback on that.” And so they have a two-week structure in which they say, “Okay,” they do the framework, “this is the opportunity we think we see.” And very quickly create something that people can interact with it, might be something as simple as: write out exactly what you think your value proposition is, and now inclusive of for whom it is, now go find people that you think this is for, and test, have conversations with them, interview them to see if you're actually right, you've gotten this. And so, at the end of this, you end up with a refined value proposition. Or you realize like yeah we

were completely wrong, but so there's that evolution. Or you have an idea ... you believe that you have an idea for the product, okay so make some physical embodiment of that product, some prototype, that you can now very quickly go and put in front of people, go put it in front of a bunch of people, and get feedback on it. And so this is ... and all this is within the two-week time frame. And so it's getting them into this habit of saying, "let's articulate our hypothesis; figure out the best way to test that. Let's gather some data. And let's use that as a means to figure out what it is we're going to do next." The two-week cycle is forcing them to actually get out of their own heads and put it out in the world and get that feedback, because often we know the most important learning happens when it actually hits daylight: "Oh that's what this is!" And then they can say ... And so they have to do that sort of complete thing in the span of that expect two weeks. But then they can, if they choose, on their next team for the next two weeks, they could pick that same ball back up, but they have to put the ball down and pick it back up, because if instead they'd have four weeks, they wouldn't have been ... and we have experienced that as well ... left their own devices. The work expands to fill the container, right? And so sort of in broad strokes, they can learn 80 to 90% of what they would learn in four weeks in two weeks, so let's accelerate that, and let's do it again, and let's do it again. And so that's the structure that we're trying to get them used to so that, when they get in ... so at the end of the semester we let them, for the back half of the semester, we've let them work on projects: they can pick whatever they want, they can form their own team, they have to do it in two-week long sprints, so they are four weeks, but they develop this muscle, this ability to say, "Let's do as much as we can in two weeks. And let's learn from that. And then do it again." And so they can actually be incredibly productive over the course of those four weeks and learn a lot because they've developed the skill set of engaging in these rapid experiments."

Overall, faculty participants' in the EM-context showed creative approaches and thoughtful ways to implementing curricular change. At the same time, they pursued these activities while balancing competing values between the scale of implementation and its impact on student learning, as well as between what the change can bring and the amount of effort involved. Kaleb, for example, provided the following insight:

"Yeah, it happens in a number of courses. And one of the shifts in the creation of this course was shifting it from a course that was taught by an individual instructor to one that was co-taught, for some of the reasons I've described before. And I think that if we look especially with respect to our required courses, a lot of the most influential, and actually just a number of the required courses, are co-taught. And so you get the perspectives of multiple faculty and the attention of multiple faculty in the context of these courses."

While the integration effort described by Kaleb involved multiple faculty co-teaching courses, Connor described how his integration of EM involved issues around social justice in a subset of classes where he could contribute:

“Yes and no. I'm trying to integrate ... and I'm going to be as fair as I can be ... not EM across the curriculum, I'm motivated to integrate social justice issues and awareness in the curriculum. EML is for me a means to achieve that because I can convince my colleagues that I'm pursuing a route of creation of value for communities, which makes my efforts more universally accepted than it is for me to say, “I'm talking about social justice issues when I brought that up.” So my colleague say that's a policy issue; that's not an engineering issue. So I'm using EML as a bridge to raise that type of learning in my courses. So that's part of the answer. The other part of the answer is I'm only doing that, to be very honest, in my engineering mechanics courses. So I do this in statics, dynamics, mechanics of materials, structural analysis, and technically engineering materials but that's not quite engineering mechanics. So in those five topical areas that's where I'm doing these types of activities. The first-year engineering course that I teach and the senior design course that I teach I don't touch those, mostly because of how coordinated they are. So it requires too much buy-in for there to be a change in how those courses are taught. EM pervades those courses but not in the way that I'm trying to actualize social justice issues through here, if that makes sense.”

Overall, while faculty participants' in the quantitative phase showed no correlation with *attitude toward context* (Finding IV), they pursued their effort of change while balancing competing values; they seemed to navigate through their contexts and fulfill the interest in making an impact.

Context II: The COVID-context

In the COVID-context, the development and implementation of curricular change was largely related to the impact that the pandemic had of making communications virtual. For faculty participants, they saw this change to be significant in the beginning, but then it became natural. Xavier provided the following insight:

“At the beginning, yes, but I think there was a lot of friction from the students, especially in the beginning of COVID ... there was a lot of friction ... in the beginning when we just started, I actually wanted them to use Microsoft Teams and maybe Whiteboards and all these tools that now, after a year of COVID is more natural for all of us. But at the beginning of COVID, it was actually very challenging and there was a lot of friction.”

Griffin provided a similar insight in the capstone design he taught and coordinated:

“For the capstone courses that I teach probably the biggest changes we made were we did all of the lectures online because we had ... it was a fairly large group. Well, actually, so for the fall-spring offering, so this would be the one that started in fall 2020, we did everything online. For the spring-fall one ... the one that started in spring of 2021 ... we did everything combined face-to-face and online. And also students could attend if they wanted to, and then they could do it online if they wanted to. Most of them did it online. [...] And my experience has been that students actually do better in online presentations than they do in face-to-face presentations. That kind of surprised me, but it seems to be pretty consistent that their online presentations were better. But we also [did] the showcase which is sort of the big celebration at the end of the semester, at the end of the senior class. We did it in December, and also this April we did that entirely online ... actually last March, you know. A year ago March we did it online, too. It turned out to be about a third as much fun as doing it face-to-face.”

For Vagish, who is a research-focused faculty, he tried to find creative ways to respond to the pandemic and deliver his class. He shared a different approach of how he implemented change in his class:

“It was pretty unique to our class. So I can tell you a little bit about the activities with it. So the first set of activities, virtually, my colleague did like a movie night or like watch a clip of a film like Blade Runner and talk about it ... so kind of like a book discussion kind of thing with a small group ... I did something where they could come to campus and we walked in the morning and we walked outside and wrote haikus outside—haiku like Japanese poetry, because the unit was paper and paper prototyping, so like stories and poems and stuff like that. So that was the first activity. The second activity I did two things: I did a Blender—Blender is 3D rendering software—we did the online or in-person Belndering workshop where I helped them with their 3D prototypes and designing them and how to color them effectively and basically for virtual objects. So that was one. The other one that I did was we actually ran a D&D--Dungeons and Dragons game—where I host the dungeon master and we made it set in the story of the novel we're reading. So we

were reading the science fiction novel called *Neuromancer*; it actually inspired like you know the *Matrix* and other kinds of things. It's a book from the 1980s. And we created a *Dungeons and Dragons* campaign, just for an hour, where students could come and ... like I had five students came in person. We kind of did a *Dungeons and Dragons* campaign. We'd like ruled the like 20- sided die. And it was a way to get them to think about the book and the novel but do it in an interactive fashion online. So that was that activity and I think that's it for activities we did outside.”

The response by Vagish provides a counterintuitive depiction of the connotation about research-focused faculty’s limited ability to adjust. Vagish, himself, said about himself that, “Yeah, I mean honestly I probably spent more time trying to figure out how to keep my research lab going than I worried about the teaching. And that's maybe because of my role, but like teaching is not ... I teach usually one class a semester. So like it's I'm not teaching-heavy focused and so ...” A similar observation was provided by Mary:

“So we are an R2 institution. And we have too many administrators who want us to be an R1. So there's a heavy emphasis on research. The people who are the most research active are the ones who get the most attention. It just is; that's the way it is on our campus. So teaching is not always valued as much as it should be. My position ... so I am at the top of the non-tenure track food chain. So I'm a professor of practice; there's three other levels below me. In effect, I have tenure; I don't have a contract. I basically have a path of what would be equivalent of tenure. But there is an expectation that I do have research—just submitted a National Science Foundation grant, waiting to hear on that. I'm expected to do a paper every year. I usually do two to three papers a year; in fact, had two journal papers published in the spring on COVID-related stuff. I'm working on a conference paper right now. So yeah, and pretty heavy service load as well. So institution focuses a lot on research; the expectation is that I focus on teaching and service, but there is also a heavy research component to it as well.”

Yet, from the examples provided by Vagish, there is clearly thoughtful effort in providing effective learning experience to the students, despite the common understanding that research-focused faculty just focus on research. This may help explain the quantitative finding about the lack of difference in *self-efficacy in adjusting* across contexts, with the high correlation with *attitude toward context* in the faculty participants in the COVID-context

(Finding I). It also helps explain the higher *willingness for adjusting* of teaching-focused faculty compared to research-focused faculty (Finding III), even though there was no difference in *self-efficacy in adjusting*.

5.2 Coordination efforts in curricular change

Context I: The EM-context

In the EM-context, the coordination of efforts in curricular change involved the discussion, evaluation and support for curricular change efforts in the faculty participants' institutions.

Vera described the coordination effort that takes place on her campus:

“Yeah, so our KEEN is across the college of engineering and we're a pretty school small school, so our college of engineering has ... I don't know ... call it roughly about 40 full-time, tenure-track, tenured faculty. So we do different things with KEEN network. We have somebody on-site who kind of coordinates across the college, and each year I think the implementation looks a little bit different. So for one example is that me and one of the other people that I collaborated with on that course, we were actually in position that's a rotating thing, so the last two years, we were co-chairs of that. And so, as part of that we led a community of practice for engineering faculty and in that community of practice at least several sessions of our get-together discussions or talks or speakers were related to KEEN or EML-focused. So that was the last two years. And before that the person who led it also did something similar. So KEEN elements have been integrated into a lot of our faculty community of practice or discussion group types of things. So that's the main thing that's brought light to. And that's all voluntary so, you know, some people are more into it or willing to participate than others, naturally. But it does allow us to reach a significant fraction of the faculty. And I guess the other thing I'll add ... so I'm not involved in this, but the person I mentioned to you kind of manages KEEN at my university, has just put together a series of videos on EML and KEEN. And so I'm supposed to be reviewing them and I haven't got to it, yet. But, still, they're out there and his intention was to be able to show them to new people coming in, or those who aren't familiar with KEEN to can give them some groundwork.”

Jack shared how he engages with discussions with the KEEN coordinator to provide his insight on how to improve the integration of EM across the curriculum:

“So my conclusion was that if we want to create or foster the entrepreneurial mindset, we have to begin very early, very early. And this is what I shared with EM team. All the leaders when I spoke to them, formally or informally, I say you have to begin early, the second semester ... first, second semester ... from the bottom. So when they get to the middle of their career, third, fourth year, they already know, I mean that they are really made, so that they know what to look for. When we started presenting this, it was the capstone, and I realized that it was too late. So I said no, we need to begin at the lower level. So they started looking at a lower level courses.”

Xavier described his role as part of the core team on his campus to integrate EM:

“It was part of a university effort. So we have a group of faculty that lead all the KEEN-related activities, and I am a member of the core team. We actually are currently conducting a multi-year project, sponsored by KEEN, related to EM and making: how to integrate entrepreneurial-minded learning and making activities, like maker spaces and machine shops. So that actually brought me to KEEN and we are working together to spread out the KEEN idea and philosophy. So as part of that core team, I have like first-hand experience on KEEN, and we go to workshops, we go to the annual meeting, and so on and so forth. But we also spread the word to other faculty and, yeah. So I would say it's a university-effort.”

Robert provided how the e-portfolio became integrated across the curriculum in a university-wide effort, within the College of Engineering and beyond:

“So for e-portfolios, [...] the university have said that they're interested in looking at, what that might look like, and to academic units have piloted the use of the portfolio. Engineering is one of them. So what we decided to do was we put forth a call to our faculty and said, “Hey, would you be interested in participating in this workshop? This workshop is about e-portfolios. Here's what will be expected, and here's the deliverable.” So they had to create a project for the students to complete that they would do with them before. We also partner with them. Part of participating in the workshop is they received a stipend because it was over the summer. So for this participation of workshop they received the stipend; the stipend was paid with the completion of the workshop, and the other half of the second was paid after the projects were uploaded into the e-portfolio platform. Then we put out another request to say, “Hey, if you're interested in doing this more and you see merit in it, we will help you get these programs up to speed in your class,” because what we're trying to do is have 100% coverage of our students. So from that standpoint, the initial target were classes that all of our students would participate in. So, for the first year, it would be the spring semester course; for the second year, it was two courses ... actually, it was engineering design as well as statics and dynamics; third year, was engineering design then the next part of engineering design in the third year; and then we had a sustainability course that utilize to e-portfolios. So,

right now it's just that group of faculty members and then other faculty members within the department who have expressed interest after we explained the results. So we're in the process of gathering and giving updates in faculty meetings.”

Overall, the coordination of efforts to integrate the EM across the curriculum involved periodic discussions and interactions in order to facilitate the implementation of change.

Context II: The COVID-context

In the COVID-context, the coordination of efforts in curricular change took the form of continuous evaluation of the shared responsibility to respond to the pandemic. Mary, for example, shared how her expertise as a Quality Matters reviewer for evaluating online instruction before the pandemic became valuable to her and her colleagues during the pandemic:

“Yes, definitely. I'm also a quality matters reviewer so that means I can review other people's online courses using a quality matters rubric, which is pretty much the standard now for evaluating online instruction, or at least online course design. [...] So that one was really ... I would say it was you know ... it changed my teaching, definitely, and set me up very well for COVID because then I was better able to mentor some of our other faculty when COVID hit and they had never done any of these things; they've never done the flipped classroom or any online teaching. So it really put me in a position to help them.”

Sophie described the coordination in terms of support she received from the Dean as a major enabler to succeed during the pandemic:

“Major enabler was the fact that our Dean was on-board wanting to say, you know, if we needed something, if we needed money, even though giant schools had a giant budget crisis ... she was on board. So the very top of the pyramid was on-board with making freshmen classes the best we can do. I also had a three-person design team that kind of got put together, not an official aspect, like they weren't officially part of first year curriculum, but one person is on the Dean's leadership committee. He's helped a lot curriculum development; the other is the new first-year director, and

that was his first year as the first-year director, and that's also a brand new position, so, peeling that out. And we also had some input from our scheduler and accreditation/assessment person for the college, because she was a student as well. So we kind of had her for some background on the university and stuff like that. So we had this team, and that was really helpful, of different positions and stuff. But I'd honestly say the biggest thing was the support from the Dean's office, and the Dean herself."

For faculty participants in the COVID-context, the coordination efforts were essential to support the faculty in adapting to the new modalities of teaching.

5.3 Displaying awareness of what is involved in curricular change

Context I: The EM-context

In the EM-context awareness of integrating the EM involved knowing what others are doing as part of the KEEN network. Brooke, who shared a reserved view to limiting the notion of value in the EM framework to financial gains, described her behavior when she is interacting with others in the network as follows:

"Yes, so when I'm with the KEEN people and I'm hanging out and I'm using KEEN lingo, then, yes I expand the definition of value to be more than financial, and so that includes social impact, that includes even impact for an individual. So, for example, we do projects all over the place that we might do a project for a physician or nurse for person with a disability or for ... in my two o'clock meeting is with the [water association]. We built them ways to collect trash on their streams. Just all over the place, right? And so, "value" can be solving a problem. It doesn't have to be, again, what Mr. Kern thought of it as value, which is financial. So yes, I expand the definition because that's important to me."

Connor showed this awareness when he made a comparison between how his department implements EM with other departments' way of implementation:

"So let me offer a very broad response—so, well, at least contextualize how KEEN manifests itself here ... The EML framework manifests itself ... I will say that the curriculum was already established before my department became engaged with KEEN as a partner school. So our curriculum does not, compared to other

departments, reflect the EML framework. We can in part look like a traditional engineering mechanics based curriculum. It's two factors, I believe, we have a very strong champion of KEEN at our institution. It's pervasive. Everything he would do was couched in KEEN. So whether it was student co-curricular experiences, or department grant opportunities, or in how he would structure and share out the learnings of his classes. KEEN was everywhere: student curiosity, creating connections, creating value. He would send people to as many of the KEEN events that he thought, particularly the young faculty, myself included. I think, with that there was sort of a critical community in my department that has formed where it's very natural to not talk about KEEN. We don't have meetings about it, but to simply that pervade everything that we do as it blends with all of our other interest in different pedagogies. I will say that this is a critical community; that's not the majority of our department. There's another segment of our department who, in part, are not regularly active in KEEN. They tend to be older, more established faculty. So, for whatever reason, maybe they're just established and comfortable on what they do they're not as active in using some of the KEEN language or KEEN student learning outcomes in their own teaching, or at minimum they're not espousing how they do this in their classrooms. That's I think that's one part of the answer; I'm not sure if I captured it all.”

This awareness, however, did not show up as an *attitude toward the context* (Finding IV). In Kaleb’s response, he described how the EM integration efforts on his campus were actually shared with others in the network, as they were ongoing even before his university’s involvement with KEEN. In his response, he shows awareness to what might be taking place on other campuses:

“I think it came in and supported in the many ways ... and maybe supported or bolstered some of the directions we were already going. It's certainly influenced them, but it was ... some schools you look at and say, “Oh, they weren't thinking about entrepreneurship and all the right thing,” so, it's a wholesale sort of shift in direction. That was not the case and I think that that was even the nature of our interaction engagement with KEEN in that, “Oh wow, how do we amplify some of the things that you’re already doing, and refine, and maybe put up, or hone some of the things that you’re doing” as opposed to needing to create things from zero. We certainly weren't at zero.”

Similar to Kaleb’s response is Alex’s description of a workshop they delivered to the KEEN network:

“At KEEN, I’m kind of known a bit in the world [in my specialty]. And the many of other scholars, other faculty who are members of the KEEN network, who we met at the conference there were saying, “Oh God, you know how the hell do you do [that]?” And then we gave that little two-hour workshop, and they were like, “Oh, can I borrow back? Can I have that? Can I steal that?” We were like, “Well, no, not really. It’s not public domain. Yada yada.” But KEEN then said to us, “Hey, would you develop some material that we can use and disseminate, and we’ll give you a grant?” So KEEN would have given us 150K grant, I think it is, to develop a whole bunch of video material, and taught material, and stuff, for them to put into their system, to disseminate out to other universities. And presumably we might go and do boot camps on that as well; that’ll be ready. It’s got another year to go that grant, I think. And that’ll be ready next summer. So that’s a big push from us out. I can’t think of a single thing we’ve pulled in.”

Overall, in the EM-context, and as a component of *self-efficacy in adjusting*, displaying awareness of what is involved in curricular change was present through awareness of what others were doing in the KEEN network.

Context II: The COVID-context

In the COVID-context, displaying awareness of what was involved in curricular change was shown in terms of faculty participants’ understanding of their ownership of change, and the interaction between autonomy and accountability. Mary, for example, showed this awareness by sharing her awareness of what might go wrong:

“Um ... I would say that the risk is what if I did something that actually hindered students’ learning—that’s what’s most important to me is making sure that everything I do has a positive effect on their learning. One of our students’ biggest complaints with Canvas is that faculty often don’t put enough thought into how their Canvas courses are designed, which means it’s hard to find things. So if you’ve got folders within folders within folders, it can be difficult for students to navigate that. So that’s where the risk came in. Is this going to actually make things more difficult for them in terms of navigation, or will it make it easier? Now, it turned out that it made it much easier for them. Not that there was really a problem before, the students always talked about how organized my courses were, but you know anytime when you have something that’s successful and anytime you make a change you’re

taking a risk there, because like, “Okay, is it going to be less successful now?” So yeah.”

As for Vagish, he described the issue of accountability in terms of the university’s oversight, which he characterized it as being limited (Finding II):

“Um I think the university usually is very hands-off. Okay, well, I’ll tell you how hands-off they were. Technically, I was supposed to teach in-person, in the fall and spring last year, and I just didn’t. So, it was supposed to be a hybrid class, like technically there were supposed to be people if they wanted to come in, they could come in and I was supposed to teach there physically and do a hybrid class. But I realized early on ... I was like a hybrid class is the worst of both worlds. We would have been sitting there; I would have been in there with a mask, talking into a computer; they would have been at a computer. So just before the first day I just sent a message to both sets of students. I said, “the first two weeks we’re going to be virtual,” just because I wanted to do that. And then, basically, I never told them I was going back in person. Nobody ever asked. And I left it at that. Actually, there was a little bit of worry because one of my departments was like, “Oh we’re going to be checking classrooms to see that you’re there in-person,” because I think this was a common problem where they said, most ... all classes will be hybrid, but it turned out maybe like 10% were actually in-person ... most teachers just ignored it, and I ignored it. I was like, you know, if they show up in my classroom and nobody’s there, I’ll deal with the consequences. By the time they do anything serious ... I was like by the time they send it up the chain to get me in trouble in something, the pandemic will be over, because you know they’re probably have bigger things to worry about than whether I’m teaching physically, in-person in this one room. So that was one thing that I feel like they were very hands-off, and truthfully nobody ever came, nobody ever complained that I wasn’t in that class physically teaching. So I think they didn’t get much guidance. They were just like ... yeah, they gave no guidance basically in that sense.”

Miles provided the following insight in terms of his ownership of change and the autonomy he had, by comparing the adjustments he made for EM activities with the adjustments he made during COVID:

“I mean the most amount of my time has been on the COVID-related changes. It just changed ... it touched and changed every single course. Whereas if I’m going to try to make some EM changes, there are some courses where I have more control and less control. So the circuits course that I mentioned, I have complete control over it. I’ll do what I want. The sophomore design sequence; that’s not my baby. I just kind of follow along. So yeah. And the people on that are very EM people, but

just as an example, that's not my specialty. That's not my area. I'm not going to try to put a lot there. So, simply because COVID touched more things, and touched everything we did, I think I would call that more significant on that level.”

The description by Miles on how “COVID touched more things” resonates with Finding I about the higher correlation between *self-efficacy in adjusting* and *attitude toward context* for faculty participants in Context II. Overall, faculty participants’ awareness of the context within which they behaving was part of their *self-efficacy in adjusting*, but that awareness did not always alter their *attitude toward context*, which may explain the lack of difference in *self-efficacy in adjusting* across the two contexts of this study (Finding I).

5. Differences in *willingness for reflecting*

The *willingness for reflecting* illustrates the quality of being intentional in considering and reviewing past performance in order to use outcomes to improve future efforts. This involves (1) **observing** one’s performance; (2) **evaluating** past accomplishments retrospectively; and (3) **monitoring** task-context relationships. Faculty participants portrayed varying levels of *willingness for reflecting* in the two contexts of this study.

6.1 Observing one’s performance

Context I: The EM-context

In the EM-context, observing one’s performance was pursued through discussions with other faculty about the EM implementation. In Vera’s case, she shared how she always seeks new tools to enhance her performance and gets input from her community of practice:

“ Yeah, I mean definitely there's some extent always thinking about new tools and new learning processes—that 's what I really love about our community of practice,

is that, you know, we go in and just talking about best practices and talking about this or that. And it really drives to this session. So, yes, definitely always willing to pick up tools from other people and recognize that certain things work well for some people and don't work well for others. So figuring out what works best for me. And I think that's the same in everybody else's case.”

For Jack, observing his performance was associated with an awareness of the pressure related to implementing change:

“But EM is great. To me, it’s great. But what is not so great is the level of stress, I mean, because of the nature of the design project. If I were teaching theory-focused, 200-level, yeah I can probably do EM there. And I do; I do in theory-focused, 200-level. Do it in various but limited way, but I do it, from the perspective of always creating value, creating value for the customer, creating value for the user. You're here to improve things. I mean that's standard pitch. But with capstone, I cannot. I couldn't use this structure as a way; I struggled. And my other peers who teach capstone, after going through this for two semesters, they said, “You know what? I’m out. Not going to be part of this. I'm doing the same thing but I don't need these assessments.” So he backed off. I continued because I saw some value. Continued, created the assessment matrix, for me, for what I do, which are unique problems. I mean I could do it, right? I could do it, but requires much, much, much more time.”

Context II: The COVID-context

In the COVID-context, observing one’s performance was also related to an awareness of the pressure brought about by the pandemic; the difference, though, is that faculty participants did not seem to be intentional about reflecting as they were overwhelmed by the pandemic situation (Finding I). Vagish provided the following insight:

“Um, I don't think I was that intentional. I think, again, I was just trying to get through. Honestly, there was a lot of fires to fight. I was so worried about the students in class; they were not the ones that I was worried about, it was the students who were, you know, dropping out or they tell like their family members were getting sick and they needed extensions, or they were isolated, especially with that 100-person class. I think that 30-person class you don't get that as many, but when you get up to a 100, those rare event things start to become less rare. At least like a couple of our students actually got COVID, that we had to deal with that. Some of them had a family member lost or something like that. So I think I wasn't really

focusing too much on whether students learned or not; I was just worried of whether the students were going to complete everything on time and get through the semester. So that was kind of more focus.”

As for observing one’s performance as part of *willingness for reflection*, Miles questioned the value of reflection given that the entire situation was unique and may not applicable in the future:

“A little bit, but it's hard to know how useful that reflection would be, right? Like yes some things have worked well, and yes, some things haven't. But let's say I get positive feedback on something I did, well, maybe I'll never do it. And let's say I get negative feedback on something, well, yes, I know I did a bad job because we were all online. So it's really ... I think I have reflected but it's hard to understand. It's hard for me to value what I've done over the last year and a half of like what's good what's bad. There are some things that I can do, like, you know, some independent studies have worked; my research students have been good, but coursework-wise, I'm never going to do the take-home-lab-kit again. I just don't think that's worthwhile. Yeah, it's hard to know. As an aside, I think we're all going to have some form of post-traumatic stress disorder for the next five years and will never know it. Like five years from now. We'll all realize that we've all been angry, for two years because of this. But, yeah, it's been odd.”

For Sophie, however, she recognized that the pandemic might have enabled change, but it was not without stress (Finding I):

“I think COVID might have helped because, like I said, we had the support from the Dean. And I think I was able to meet with the team more often, because we could do the Zoom. And because there was this big push of being like, “Look, we need to do something about this course, and it needs to be good. And if we're putting time into adapting into virtual, you might as well fix the whole thing at the same time.” So, I think that was really the big ... as much as it was a huge stressor on me to adapt the course in one summer, I think that was the really big push that the university needed, the college needed to say, “You know what, we're going to start this course from scratch again and redo it to make it better for the students.” So, yeah I think it was a blessing in disguise.”

Overall, observing one's performance as part of *willingness for reflecting* was part of self-experimenting accompanied by a process of reflecting in-action. In the case of curricular change, the process was not without related stresses on faculty participants.

6.2 Evaluating past accomplishments retrospectively

Context I: The EM-context

In the EM-context, evaluating past accomplishments was part of a deeper attempt to gain understanding of how EM can better be integrated into courses. Consider the following insight from Kaleb:

“Yeah, I mean it's not necessarily real-time, but just step back and say what's working what's not working here. Because also students change and so year over year sort of students ... you have we have to adapt ... we adapt as a function of what happens within the course but also we adapt as a function of the inputs to the course which are students.”

For Alex, part of the evaluation was seeking students' input, but that also did not happen during the semester:

“I don't think we ask students kind of what they think as we go along. I don't think we do that; maybe we could; maybe we should. But, absolutely, we do an exercise for a week or two, and if it kind of turns out ugly it's absolutely note to self, “You know, that didn't work. Need to come up with a better idea next time.” And that often has a lot to do with how much work it throws back on us. If the exercise is horrible and ugly and we get very variable results from it, then clearly we need to polish it and think again. So absolutely we're keeping scribbled notes in the background, which is, “That didn't work, you know, try and make it better.” I don't think we do ... and then at end assessment we get, the formal feedback, and often it will refer to something that we already got a year, we know that.”

Connor also tried to relate the evaluation on the outcome it has on students:

“In terms of how I'm reacting to what the students have generated, in some part, I reflect and think I did not offer enough clarity toward something. Or that I needed to have provided more resources for something. I rarely fault the students because in

my own thinking students are ... I'm assuming positive intent, and I'm assuming the students are doing the job as best as they can of what they think I'm asking them to do. So if they are reporting something that I did not ask for, I usually fault ... I don't fault them, but I suspect that something I said, or something I wrote in the past, it's what's causing that. I often will just have a conversation, "Oh, why did you do it this way?" And they'll usually say, "Well, in paragraph 2 sentence 4, you said to do this this way." And so I'll often go back and say, "Well, maybe I was unclear." Is that answering the question. I'm not sure if it's."

For Ralph, he acknowledged a level of anxiety when he implemented any change, but he embraced the outcome as a learning moment and related that to the students:

"At first I was anxious, but then I didn't worry about ... So this is the other part that the researchers don't like about me. And the part of it is this: I'm of the of the mindset that everything is a learning moment if you accept it. You may not like the outcomes, but it's still a learning moment. It may not be what you intended, but that's the impact. And the question is not how many times you've fallen down; it's more about how many times do you get up. So for my students, I like to create this environment where I go, I don't know what's going to happen and we'll find out together"

Overall, for faculty participants in the EM-context, the deeper, retrospective evaluation of the EM integration was always related to the outcome it had on students.

Context II: The COVID-context

In the COVID-context, evaluating accomplishments during the pandemic was related to understanding what worked well and what can be used in the future. Vera shared her intent to make this evaluation:

"Ideally yes. An actuality we've run into some issues with actually having a sound evaluation of whether it works or not. But yeah my intent would be to be able to say, "What did we do didn't work? Did it not? What can we improve?"

For Vagish he shared the things he tried during the pandemic that he may or may not continue doing:

“You know, I’m torn on the idea of recording lectures. Some students liked it, but some students then take it as an excuse and then they kind of zone out and don’t come to class and stuff like that. So I don't think I’m going to record my lectures. I think this fall I have to if there's an asynchronous student, we're supposed to do it. So I want to do that. Some of these experiential activities, I might do. It might be like the D&D game; might be fun to do in-person again. So like some of them I could do. So yeah I think only the experiential activities perhaps. And that was it. I don't know if any of the other things, like the video recording, I don't really like it too much. I mean I don't mind it if ... but then I'm kind of stuck to a computer, and I like to walk around when I teach. So I don't think I would do the video recording unless I have to.”

Mary also shared some of the things she tried and was considering to keep:

“Definitely, the breakout rooms and teaching an asynchronous online class. As I said, I like to do a lot of in-class activities, so get the students talking to each other, working on answering some questions about things. And we obviously lost that in-person environment. So in the fall, that's when I tried to do things with the breakout rooms and that took a lot of thought: designing activities that they would be able to do where they could talk with each other and making sure that we're in small enough groups that they could have a meaningful conversation and then report out. That was the biggest change that I made in my classes, and it's one thing that I'm going to keep regardless of if we're back on campus or not; is this using those breakout rooms, even while we're sitting in the classroom, not necessarily the Zoom but the activities that I designed, keeping people in the same groups. It just worked out really well.”

Sophie shared a similar insight on the use of lab resources:

“Yeah so the when we originally were designing, especially the Arduinos, it was always just using the actual Arduino and using the Arduino IDE on the computer. And now, that I've used the Tinkercad, or the students had to be forced to switch over to Tinkercad, I see the value in keeping that for our interest in classes in this upcoming fall. I'm at least keeping an aspect of it.”

Overall, for faculty participants in the COVID-context, the deeper, retrospective evaluation of the impact of the pandemic was related to tools, techniques and approaches that faculty had the chance to experiment with and were considering keeping.

6.3 Monitoring task-context relationships

Context I: The EM-context

In the EM-context, monitoring task-context relationships was associated with how faculty perceived of the task of change in respect to the context within which this task takes place.

Jack, for example, tried to relate the EM integration effort with the ABET standards:

“I think EM ... I got the benefit because [of] I got some structure. There were things that I didn't like much. I don't know if they are unique to this university or not. The assessment part. So when I have to assess, I assess in my own manner because I see the results. When we look at ABET, right, ABET has objectives A-K or 1-7. And then you have the students' objectives. We came with a 22 or something like that ... A through M or something like that ... which was more granularity, but in the end I care about this: did the students produce something of value? That's it. That's what I look at in the end. And that is not to assess, because every project is different. It is not something that you can predict.”

The point by Jack about the actual benefit that the students get from the integration resonated with Robert's in his attempt to put the task in its context:

“it's amazing to me how the students, given that scaffolding of, really you're there if and when I need you, and them, knowing that if they do stumble and even if they do fall, I'm not going to discard them, I'm going to help them get back up [...] I've got some students who in the past who all they knew to build was the front base of the portfolio. They think I wouldn't check. And I saw a bill. And then we have a discussion, “Okay, why did you think that would be a good idea? Well, so what did you learn from this? And if this was your professional occupation, would you have done that? Or how might it be seen if you did that on your job?” So that has nothing to do with the portfolios; it has nothing to do with the class, but it has everything to do with them. So. I'm a different animal when it comes to stuff like this.”

For faculty participants in the EM context, the *willingness for reflecting* on the larger impact that the integration effort would have on the students was present in their efforts to put the task of integration into its larger context.

Context II: The COVID-context

In the COVID-context, monitoring task-context relationships was associated with a heightened level of awareness of how the context of the pandemic impacting students' behavior. Consider Xavier's reflecting on the task-context relationship he was faced to deal with:

“Well, both the ... as I remember ... both the lockdown itself and the resistance, because I planned a lot of physical activities. And then, as I was trying to make these things virtually, the students didn't respond as I was expecting. I think if that happened now maybe some students will be more adjusted to that environment, but in the early COVID-19 it was way harder.”

Mary related some of her ongoing research and some of the impact that the pandemic has had on the students:

“Well, I can tell you that going away from senior design for a moment and my graduate classes and focusing on these practice courses, I have research going on studying how students responded to COVID over time, and one of the things that the students are telling me is their interpersonal communication skills have improved during COVID because they didn't have any choice but to improve them, meaning that they had to make more of an effort to stay in-touch with their teammates and their group mates because a lot of these assignments in these practice courses are group-based, which meant that everybody had to be in communication with each other, using a range of tools”

Griffin elaborated on the impact the pandemic has had on the students, and how he was observing and making connection between teaching in the pandemic and before:

“Well, so my observation is that there was a very broad range of student responses, and this is also the case when we're meeting face-to-face, but I think the pandemic exacerbated it. So the students that were already busy with work and family issues were ... there were a lot of students that I think that were more ... that had less bandwidth to contribute to their teams and so on. And some of them I think specifically due to situations brought about by the pandemic; others, you know, what we often see in teams is sometimes one or two team members, for whatever reason, just sort of check out. And I think the checking out behavior was more pronounced during the pandemic.”

Overall, monitoring the task-context relationship during the pandemic was associated with a heightened awareness of the impact that the pandemic has had on students and how was that impacting faculty's effort to adapt.

6. Differences in *self-efficacy in reflecting*

The *self-efficacy in reflecting* illustrates the quality of effectively being able to reflect on one's performance to transform lessons learned into practice for the future. This involves (1) utilizing **reflective strategies** with open-mindedness; (2) **collecting data** to inform the evaluation process; and (3) constantly **focusing on the student outcome** and how change is impacting students. Faculty participants portrayed varying levels of *self-efficacy in reflecting* in the two contexts of this study.

6.1 Utilizing effective strategies with open-mindedness

Context I: The EM-context

In the EM-context, faculty participants sought different ways to evaluate their performance. Vera shared the coordination that took place in *reflecting* given the rotation that happens in teaching her class:

“Yeah, so I guess there's a handful of reasons. One is that, we have like I said, multiple people teaching the class on different rotational cycles, and so our first question was, “Can we use data of before where we didn't have necessarily the assessment tools in place versus when we actually changed the lab?” Then we have in our assessment ... was a basic survey that we're looking at and some reflection pieces. But how can we capture the “before-piece” when we're already moving forward with putting the lab modifications in place. So that was one circle.”

Robert shared his efforts to reevaluate the e-portfolio platform. He mentioned how he had a student hired in the summer to help him in this:

“That's part of what we're trying to do this summer, because there are things within the platform that we're using where you can embed into the assessment. Different learning objectives or, based off of different criteria. So it could be the department; it could be different things that have come up in the past. So we're in a process right now of how do we create the infrastructure within the portfolio system to do that, because what you have to do is tag certain things and then you have to have something that's connected to this other piece that has all the criteria and then you can actually build reports that stay you meet objective X, Y and Z with this one from, that comes from this year and that year, and all that stuff. So we're in the process of doing that now to see how we might be able to capture and leverage that information through the system that we're using.”

Xavier shared how he utilized midterm evaluations to help him in the reflection process:

“I do both. I always like to have a personnel midterm evaluation of the course. And I did that in the course and I got some comments actually for improvement. And also, I got some comments at the end of that term evaluation.”

However, there was an overall recognition of the lack of sufficient use of reflection strategies in an effective way. Consider Kaleb's comments for example:

“How do we measure the outcomes at the end of the semester... I think that we try to assess how students have been able to engage in the process. And I think that's a key element of how it is that we evaluate.”

Kaleb shared, though, that the although the process was taking place, it was not as formal. When asked about seeking feedback from other colleagues as part of reflection, he provided the following:

“Um ... I don't think we explicitly ... I don't I explicitly asked for feedback from other faculty outside of my college per se. Like, “Oh here, let's analyze this piece of my class.” I may have conversations with them, and those more informal conversations may more broadly inform kind of things that we do. But we also benefit a lot from the fact that this is a team-taught course. And so we're constantly

... I mean so for each course, we have a shared document to recapture [notes]. And so will drop experience notes for each course ... for each class into a shared document that the courses instructors also have access to. So let's track this, let's track this. We might say, "Okay, let's make sure we think about this." So, there's that running reflection sort of in-action that we accumulate. And we also have a retrospective at the end of the semester, where we do a higher-level reflection and say like, "What are some lessons we've learned? What have we learned?" And so there's a lot of dialogue between the faculty that are teaching the course, that I think would benefit from, that helps us get out of our heads, which is very different than just being one faculty member teaching a course and designing the course of the entirety on your own."

Although faculty participants were collecting data, the process of reflection was reported as an informal one. Brooke described the reflection as assessment in the following comment:

"So I would say that the assessment is ongoing. [...] And we use ... so there is that assessment. But I'm not sure that that assessment largely informs the iterations of the course. You know, it's more like, "Hey, when students went to do 3D printing, they weren't prepared," so we need to go back and change this; "you know the 3D printing module that they did in the first couple of weeks ...," right? So it's not from graded work that most of the iteration happens; it's from thoughtful conversations with the faculty and the students and with each other that informs the iteration."

For Connor the process of reflection was almost non-present:

"I don't think I am doing it, I don't know. What I'm realizing as you're asking that question is the student reflections are helping me answer one fundamental question: is their awareness of the complexity of the problem? Beyond that I'm not using it to refine future offerings in any way."

Overall, for faculty participants in the EM-context, although they sought different ways to evaluate their performance, which involved collecting data, they described the process as being informal, and some did not actually act based on the collected data. This observation may help explain the finding from the quantitative analysis of low reported *self-efficacy in reflecting*.

Context II: The COVID-context

In the COVID-context, faculty participants reported varying ways of acting on lessons learned during the pandemic, even when the pandemic was still unfolding during the data collection of this study. Mary shared how she used mid-semester surveys. She also reported the utilization of informal ways to collect data:

“Oh, a lot of different ways. So that week five survey I spend time thinking about that. I also put little sneaky discussion questions into my classes that gives me a clue as to what students are processing, and how they're processing information. Performance on assignments; obviously, that varies from semester to semester, because every class is different, every cohort of students is different. And even on a class-by-class basis, a session-by-session basis, I'll get to the end of a session and ... I don't teach back-to-back classes, which is nice ... I will usually take just even a few minutes to go, “Okay, did that work? Did it not work?” Sometimes I'll even take notes during class as to where the discussion seems to be going, what happened, where did it stall. And then, of course, with the course evaluations, I'll go through and read those and think about them. Usually there are no surprises on the course evaluations, because I do encourage those conversations throughout the semester.”

For Sophie who involved in redesigning the first-year engineering experience in her university, and was caught by the pandemic, described how data helped her in the evaluation:

“Yeah so from looking at the aspect of the fact that we did a full course redesign, the data is showing us a huge improvement in student satisfaction. And even skill set. So, from that lens of just curriculum development, huge improvement.”

Vera described her involvement within a community of practice, and how that community became especially valuable during the pandemic:

“Um yeah definitely. It's so ... So, again, I was on sabbatical the spring semester, so I had less time that I was really focusing on teaching. But the community of practice that I mentioned that I organized with a colleague, we, as soon as COVID hit, we organized that faculty group and put out a survey to all of our students and faculty trying to understand what perceptions were of new environments and what things were working on what weren't. And so we went through IRB approval and everything for that in spring as soon as it hit. As a group, we worked on and analyzing the data in hopes that we would have it prepared for the fall semester to have lessons learned coming up for, you know, these things worked in a classroom,

this is how students felt about it. And so that, again, is still in-progress, the full data analysis, but because of that we centered our workshops, our community of practice workshops, in the fall and the spring, both on more or less COVID-related topics. So fall was ... I don't know ... roughly about seven sessions that were how best practices essentially for hybrid or remote classrooms. So we had different things on using software tools like Annotations, or things like that, all the way to working with our office of diversity and inclusion, and thinking about how COVID and remote classrooms specifically impacted different student groups. And so we did that in the fall, and in the spring we did a reflections back, so, you know, what worked, what didn't, looking backwards, so that we can hopefully prepare for in the future, even as we return to in-person classrooms: What were the things that worked out of remote, and how can we better integrate those into real in-person classrooms? So that was a long response but definitely spent some time thinking about changes and things that happened during that COVID time.”

The reported examples of Mary, Sophie and Vera were rather unique on how they implemented reflection and utilized different strategies. All other participants, however, did not report active engagement of reflective practice.

6.2 Collecting data to inform the evaluation process

Context I: The EM-context

This subtheme overlaps with the previous one on different strategies, but focuses mainly on the practice of collecting the data to inform the evaluation process. In the EM-context, faculty participants reported various attempts of collecting data to inform certain decisions in their teaching practice. Brooke provided the following insight:

“So I do as much as I can in the summer. We have a framework. We have a workbook. We have the course management system setup. We have all the project scoped. And then, as the semester goes on, we make decisions or changes as we need to, but we try as best as we can to stick with the schedule. As the Semester goes on, I take notes, in the back of my notebook, about all the things that go wrong and need to be changed. And sometimes you don't know it doesn't go well until after you try it and then you got to fix it for next year. And then, at the end of the semester, we have weekly or bi-weekly meetings. Last year during COVID we had weekly meetings, and previous years we met every other week for an hour with the teaching

staff to go over what went well, what didn't go well, you know, what are we gonna do differently next time. And then also kind of looking ahead for the next couple of weeks in terms of planning. And then, at the end of the semester, we have a usually a one or two hour post-midterm where we go through maybe 25 different topics and list things that need to be improved in each of those. And then we have conversations and synthesize those, because we sometimes have conflicting views, right? Some people think we need to do more of one thing; some people think we need less. So we try to resolve those. And then, based on that feedback, we do revisions in the summer, out of the next semester.”

For Connor, he used a scaffolded approach to his project-based learning, and strategically included reflective questions to his students that he used as his collected data:

“Good question. I don't know. I am both anxious and looking forward to how student learning had transpired. I always forget the words ... In my PBLs, because it's all scaffolding, I have adopted reflections in each of the four prompts. And I ask them very pointedly to respond to three types of questions: one explain what you learned as it relates to engineering and science. So it's whatever topics we covered. Engineering design. And how the actions you undertook informed your professional self in the future. And it's that third question, and actually prompts the most interesting student responses, I believe that type of evaluation is formative ... I think it's not some of it ... So in that formative evaluation or assessment, I'm seeing students raise questions or raise thoughts about how they're conflicted and moving forward with the project, which always create excitement. It's at the very end in that final project that I get anxious and excited because I'm not sure what they're going to do. I've seen individual students reflect about their conflicts, but as a team-based report ... which I will mentioned ... as a team-based report they're having to come to a consensus about what that team of four is proposing as a solution. So that's where I get anxious because I can see the dynamics at play where a majority of the students pushed for a certain solution that overlooked one student's conflicting understanding of the problem. And I could see how that did not transpire to changing the entire team's thinking about problem.”

Interestingly, however, when asked if he actually acted upon these reflections, he shared that that was not the case: “I'll say it's oversight. I think it's an opportunity that I didn't realize was there.” Miles described how he ran “independent studies” to collect data to support his case in his department for the need to establishing new course offerings:

“So what I've done is I've run some independent studies, and so I can say topics like this have been successful, so our students can do it. I have some anecdotal evidence

in terms of in our senior year students form some learning communities around topics they wanted to learn on their own; one of them was a programming community. So I can say, “Look seniors already wanting this. We don't have it.” Students self-organized this summer wanting to teach themselves programming. So I have these data points. We have some relationships with other universities that will allow our students to move on to a graduate degree but because we lack certain courses, it makes that pathway hard. So I can use the argument by saying, “Well, students want this. They've told me this. They can be successful. And we have these relationships that we can make easier if we have these courses because right now our engineering department doesn't meet these requirements. So our students would have to go over to outside of department. Those are different people. They have different focuses.” So, yeah, I have to triangulate all the evidence because for some people in my department it's not obvious that we need these things because they come from a certain disciplinary background where it's not valued.”

Overall, there was variations in how faculty collected data, and, most importantly, the extent to which they used that data to inform future action as a crucial part in the reflection process.

Context II: The COVID-context

In the COVID-context, data collected by faculty took the form of being informal—just checking on how the students are responding to the pandemic and the new learning modality. Griffin elaborated on how he was observing the students' response:

“Well, so my observation is that there was a very broad range of student responses, and this is also the case when we're meeting face-to-face, but I think the pandemic exacerbated it. So the students that were already busy with work and family issues were ... there were a lot of students that I think that were more ... that had less bandwidth to contribute to their teams and so on. And some of them I think specifically due to situations brought about by the pandemic; others, you know, what we often see in teams is sometimes one or two team members, for whatever reason, just sort of check out. And I think the checking out behavior was more pronounced during the pandemic. And again I don't know ... in a lot of cases I don't know if it was due to challenges of the pandemic had placed on them, or due to the fact that they were less connected to their teammates; you know, the meetings are typically virtual. So I think there were more team challenges and I would attribute most of this to the pandemic than we had in the past. Some of the team members, you know,

some of the students did really well. I mean they managed to work through things. My suspicion is these were students typically with a lot of resources, you know, students who were not dependent on their job necessarily to either eat or not eat. I mean, one of the things we see in general is that by the time they're seniors most of our students are working a lot, certainly more than 20 hours a week. Some of them work 40 hours a week. And I was in one team meeting where a guy was working 60 hours a week, trying to take a full course load, and was kind of surprised, as his teammates weren't happy with his performance. So I guess the summary answer is some of the students I had a fairly good sense of how the pandemic affected them. We talked a little bit about it, but we didn't really talk a lot about it. And in a few specific cases where people would come to me and said, this is what I'm facing; I tried to be encouraging and tried to be helpful. But I pretty much just kept mostly to the class what needed to happen in the class, you know, what needed to happen to run the class.”

Vera also described the difficulty accompanied by the lack of human interaction to get feedback from the students:

“I think, in my mind, the COVID semester, the shutdown semester, was the absolute hardest for that, even though we needed it the most. Because we no longer actually had class time or contact with students. So we'd have office hours virtually; very few people ever dropped in. Emails, things like that, could go on, but there is far less feedback, just voluntary type of feedback coming in of what was going on. And, you know, in that time period, probably the most direct form of contact was like emails to the class once a week like, “Here's what you should be doing. Here's what you should be up to date on.” And then there's always notes like, “Let me know what you're struggling on. Or let me know if you want to talk.” But again very, very little feedback for that. So yeah I'm not sure if that was directly what you're asking, but it was the toughest thing that semester to get the feedback that you really needed.”

Despite the challenges of having informal feedback from students, Sophie utilized surveys to understand students' performance:

“Yes, we did give one in the middle but that was more geared towards how well things were working in the online environment, in case we had to adapt anything there. And there wasn't really anything ... there wasn't anything that they said, as far as the online environment, other than the fact they wished they weren't online, but we can't change that.”

Mary, being well-versed in online teaching, also used a similar approach:

“Um ... So we do in week five we do a survey to the students. What's working for you, what's not working for you? And students mentioned the Canvas course layout as a positive at that. So that was good. And I also explained to them, again making things explicit, “Here's why I did this. Here's why the class is set up this way. Here's the way it was before. How is this working for you?” And when it got to the end of the semester, and I reminded them of that, there would be ... there's always specific things that I would like them to comment on, in addition to whatever else they want to talk about. And in fact for that semester it was, first thing, was Canvas pages. “How did this work for you? The course design?” And then the other thing was instituting breakout rooms for group discussion and both of those were big hit, but those were two things I wanted them to talk about.”

Overall, collecting data during the pandemic was hard, and as Vera mentioned during the shutdown it “was the absolute hardest for that, even though we needed it the most.”

Overall, the faculty showed a keen interest in understanding students’ response to the new learning modality.

6.3 Focusing on the students outcome

Context I: The EM-context

In the EM-context, *self-efficacy in reflecting* by focusing on the students outcome showed as the effort by faculty to compare faculty expectations with students expectations in terms of the integration effort. Xavier shared the following:

“So, I will say that was mixed: some students love it; others disliked it. Some students felt ... back to what you asked before were my course was a design course or a theoretical course ... because the project itself, when you are doing EM and research integration, that involves some, I believe, for the way I implemented it, involved some level of design of a product or a service. And I cover actually different subjects that some of them said they were already covered in other design courses. So those students, my feeling is they didn't enjoy much the course. Actually, I got my evaluations like, “Why we are learning design again? Why we're doing design again?” So, a that was on the negative side. On the positive side, many students loved it and they perform very, very good works. And I could see they enjoyed the experience. They actually went above expectations, because I saw they were enjoying the activity. So it was like a mixed feeling. But, yeah, I think, overall, it was well-received.”

The importance of being aware of how students' feedback should be received was shared by Jack, who observed that students could not always provide accurate understanding of the intended outcomes of integration, and, therefore, their evaluations might not necessarily be as valuable. He suggested making evaluations mandatory for all students in order to get the full picture of the impact on the students:

“One thing, I think, we should do with those evaluations is that it should be mandatory for everybody, and then you would see it, then I would read them carefully. All other institutions ... where I worked, it was mandatory. And then I could see the good and the bad, and it gave me information that I could use for improvement. But the way it is right now, with it's not mandatory [...] most of them are people angry. Angry because they got something that they weren't expecting.”

Again, Xavier and Jack were among the few who commented on how they read and evaluate students' feedback on the integration effort. The difficulty of using students feedback to understand the outcome of integration, especially at a large scale, may help in explaining the low scores of the *self-efficacy in reflecting* measure in the EM-context.

Context II: The COVID-context

In the COVID-context, as described before, the difficulty of obtaining data to understand students outcome may have prevented getting valuable input. Vera, however, was trying to understand students reaction:

“Yeah ... Um you know I've been definitely toying around with some of those things that I would like to keep that were in place. So through that survey that we offered through our college of engineering, one of the biggest pieces of feedback that the students said was actually like very valuable was that many classes ended up recording lectures and so they could go back and watch them on their pace, and you know, have the material already on hand. And I've never recorded before in-person lectures, and so I'm thinking that that's probably some form of that going to be something that I'm going to incorporate better into future semesters. One specific class I would do like an outline of notes that I'd post up after class like, “Here's the

things we talked about. Here's the important points.” But I think along with doing something like that, just having recorded if you're writing whiteboard or virtual tools, instead of actual whiteboard or the chalkboard, having those recorded as resources that people can go back to, I think that is something that I would definitely like to consider in the future.”

The pandemic turned out to be a unique opportunity for faculty to try new things, after understanding the impact they saw on students’ learning:

“Yeah so we had a Qualtrics survey that we sent out to the students. The bunch of different questions. And myself and one of my colleagues spent basically all these months coding it. From 500 students. And it was a pretty long survey. So we were able to actually take that and see what the students enjoyed what they didn't enjoy, you know, their comments and really use that to decide what to do about this upcoming class. So that was a big part of my reflection; was seeing what the students said and acting on that.”

Similarly, Xavier found exploring new tools to be impactful on students’ outcome:

“Yes, I think so yeah. And actually another one is there is this tool called PollEverywhere that I explored at the beginning of COVID. And then I liked it, and then I implemented better in the fall. In the fall, we have like hybrid a classroom, but Polaris ... a tool, where students, I put the PowerPoint and then students can interact from their cell phones or from their laptops. If I ask something, the answers show up immediately on the screen, or they can show Word Clouds or things like that. So even in the last term I had hybrid teaching. I had classroom students and online students. And the classroom students, they were using their cell phones just to ask questions. And so it was fun because usually like they're shy, and they just don't ... actually before COVID, I remember asking class and everyone was silent. But here, some of the students that more shy, they use their smartphones and they just pose the questions on the screen. So I can see more interaction.”

Overall, the *self-efficacy in reflecting* for faculty during the pandemic involved mostly informal ways of assessing students’ outcome, while occasionally using survey tools to get feedback. With the lack of regular face-to-face interactions, getting immediate feedback was both difficult and limited.

Summary

In this chapter, the qualitative findings were summarized along the six dimensions for *self-efficacy in* and *willingness for planning, reflecting and adjusting*. In this research design, the mixed method used was a sequential explanatory qualitative-quantitative approach, with the focus on the quantitative phase. However, both phases were designed and conducted to meet the appropriate standard for quality if that research method stands alone. Therefore, while the emerged themes and subthemes in this chapter provide valuable insight into faculty behavior during curricular change in the two context, they will be used in the next chapter to *explain* the results from the quantitative phase.

CHAPTER 6

DISCUSSION

In this chapter, the findings of both the quantitative and qualitative studies are synthesized and situated in the larger landscape of the theory and practice of curricular development, change and the role of faculty. This chapter is organized around four major topics: (1) the meaning of the results are discussed to show how the qualitative findings *explain* the quantitative analysis results; (2) next, the results are situated within larger patterns that were reported and provided in the literature review, illustrating why they are important and fill a gap in our understanding of the role of faculty in curricular change; (3) then, a discussion is provided on how the explanations afforded by this study expand our knowledge about challenges of change; (4) finally, the practical implications of this study, in terms of faculty development and change efforts, are discussed.

1. How do the qualitative findings explain the quantitative analysis results?

Throughout the narration of the findings from the qualitative analysis (Chapter 5), references were made to how responses from faculty participants helped explain the results of the quantitative analysis (Chapter 4). Here, these links are explored in more depth. In Figure 11, a high-level overview of the emerged themes is provided. In order to answer the question, a careful consideration of Table 30 is necessary. This section summarizes the findings of the study and provides an overview of how the results can be interpreted .

1. Willingness for planning	a) Forming intention
	b) Achievement motivation
	c) Allocating time and dedicating effort
2. Self-efficacy in planning	a) Making decision
	b) Developing systematic process
	c) Dedicating time and effort
3. Willingness for adjusting	a) Motivation to change behavior
	b) Motivation to change context
	c) Taking advantage of opportunities
4. Self-efficacy in adjusting	a) Implementation of change
	b) Coordinating efforts
	c) Displaying awareness of what change involves
5. Willingness for reflecting	a) Observing performance
	b) Evaluating accomplishments
	c) Monitoring task-context relationships
6. Self-efficacy in reflecting	a) Open-mindedness and use of reflecting strategies
	b) Collecting data for reflecting
	c) Focusing on students and outcomes

Figure 11. Summary of emerged themes from the qualitative study.

Table 30. How do the qualitative findings explain the quantitative analysis results?

“QUANT” finding ^a	Associated “qual” subthemes (examples)
<p><u>Finding I:</u> COVID-context faculty participants showed higher, and overall more significant, correlations between <i>attitude toward context</i> with <i>self-efficacy</i> and <i>willingness</i> compared to the EM-context. No significant difference of means across context.</p>	<p>Forming intention / Achievement motivation / Making decisions / Motivation to change behavior / Motivation to change context / Actual implementation / Observing performance</p>
<p><u>Finding II:</u> In both contexts, correlations with attitude toward <i>context’s clarity</i> were generally higher than correlations with attitude toward <i>context’s constraints</i>.</p>	<p>Forming intention / Making decisions / Dedicated time and effort / Motivation to change behavior / Motivation to change context / Awareness of what change involves</p>
<p><u>Finding III:</u> Within the EM context, teaching-focused faculty showed higher <i>willingness</i> for <i>planning, adjusting</i> and <i>reflecting</i> activities, compared to research-focused faculty.</p>	<p>Forming intention / Actual implementation</p>
<p><u>Finding IV:</u> Within the EM context, teaching-focused faculty showed no overall significant correlation with attitude toward context.</p>	<p>Forming intention / Making decisions / Dedicated time and effort / Actual implementation / Awareness of what change involves</p>
<p><u>Finding V:</u> Within both contexts, faculty participants’ <i>willingness for adjusting</i> was not correlated with neither attitude toward <i>context’s clarity</i> nor <i>context’s constraints</i></p>	<p>Motivation to change behavior / Motivation to change context</p>

Finding I: Higher interaction with context during COVID, with similar measures across contexts

Although there was no significant difference of means of *attitude toward context*, *self-efficacy* and *willingness* across the EM- and COVID-contexts, faculty participants showed higher, and overall more significant, correlations between *attitude toward context* with both *self-efficacy* and *willingness* in the COVID-context. This result from the quantitative study was corroborated with the qualitative findings. In the COVID-context, faculty participants were observing how the pandemic was unfolding and trying to anticipate their campuses' response so they can start planning accordingly. Xavier, for example, mentioned how he was following the university guidelines, but still was influenced. Miles also showed a similar behavior when the university was not clear about its decision, his plan was to take his class to the park next to the classroom building.

One interesting observation in faculty's responses is in what seems to be contradicting on the surface, but is actually substantial. Vagish said that he was just "trying to get through the semester." Yet, in his follow-up comment, he showed substantial effort in *planning* with his colleague to deliver a quality course to his student, despite the pandemic. This may help explain the lack of difference between faculty behavior in a highly prescribed and planned context (like the EM-context) and a context that is marked with uncertainty (like the COVID-context). In both contexts, the motivation of faculty to deliver high-quality teaching was remarkable. This, for example, is shown in Griffin's effort to organize a high-quality senior capstone design experience to the students despite the pandemic.

Interestingly, faculty participants in the EM-context reported that they did not have time to implement changes during the semester. Alex, for example, mentioned that, “Nothing happens during the semester.” Although one might think that in a prescribed context (like the EM-context), faculty participants may have the leisure to fully consider the integration, what is reported is that it was hard to fully integrate EM for an entire course during the course. However, faculty participants, like Miles for examples, found workshops to be the best time to plan for activities. Miles reported that even in the summer it was hard for him to do any planning as he was focusing on his research.

Furthermore, faculty participants reported the large-scale effort involved in integrating the EM across the curriculum. This may explain the lack of clarity of the context, in a way similar to the lack of clarity in the context of the pandemic. For Jack, for example, the integration of EM in the different courses was not coordinated; he did not know what other faculty were doing in their courses. Faculty participants reported that while the KEEN workshops were effective in making them inspired about integrating the EM, they were not enough to carry out the entire effort of integration, which may help explain the similarity between the two contexts in terms of efforts around *planning*.

Many faculty shared their motivation for teaching, in both contexts. They shared strong and inspiring motivations for delivering high-quality teaching. Ralph, for example, provided a powerful and emotional description of what was important to him in teaching, beyond the technical aspects of engineering. To him, it was about helping students “negotiate life so they might have a positive impact upon the future.” The motivations overlapped between personal interests and professional interests. Vera, for example, shared

her story and the path she took as a faculty member. To her, both the research and teaching components were important, and teaching was more than “lip service.” The strong motivation to deliver quality teaching, regardless of context, may help understanding the lack of difference across contexts.

At the same time, the strong influence that the context of the pandemic on faculty participants limited their ability to change the context. That recognition of lack of control over the context, along with the absence of the human communication element with students and with colleagues, may explain the strong influence that the context has had on faculty participants during the pandemic.

One surprising finding was the lack of difference in *reflecting* behavior of faculty participants across contexts. One might think that faculty participants in the EM-context might have more time and resources to evaluate their performance; thus, they might be more *willing* and show higher *self-efficacy* in doing so. However, as for *willingness for reflecting*, across contexts, participants were always willing to assess their performance and retrospectively evaluate the impact of changes they make. What is interesting is that participants in both groups scored the lowest (around the middle of the scale, “Neither agree nor disagree”) in terms of their *reflecting self-efficacy*. The *self-efficacy in reflecting* involves the utilization of reflecting strategies, the collection of data for evaluation, and focusing on student outcomes. One implication for this finding is that perhaps with faculty being equipped with better strategies to reflect on their teaching, they might be able to adapt in a more effective way.

Finding II: In both contexts, generally higher correlations with attitude toward *context's clarity* than correlations with attitude toward *context's constraints*

One way to interpret this finding is that faculty participants, in both contexts, did not see constraints on their behavior to implement change. Jack, as an example in the EM-context, said that he was not required to do the implementation, even though, to get the incentive, he had to complete the assessment. At the same time, faculty in the EM context were aware of the scale of the effort required for effective integration, and the lack of clarity required for that. In Jack's case, he reported the lack of enough support from his administration. One would have thought that the EM integration would have been a prescribed context with clear expectation; yet, this does not seem to be the case. However, despite the lack of clarity of the EM-context due to the scale of integration, faculty did not seem to see that as a barrier; they worked on building collaborations within their institutions to move their initiatives forward. For example, Mary described how after coming from a KEEN workshop with ideas, she started thinking of how to "reframe the students' thinking" to make connections in a professional setting. She discussed the idea with other interested colleagues, without any constraints on the implementation.

For faculty participants in the COVID context, one would have thought that faculty would be constrained by the requirement of delivering courses in a specific modality. However, the surprising finding was that faculty did not report the COVID context to be restraining their behavior. One reason for that could be that as participants were seeing the pandemic situation unfolding, they were observing their campuses' response. Xavier, for example, shared that he was following the university guidelines but was also influenced by

the news coming from outside the university. The requirements by universities were not put in place by the universities without awareness of overall policies around the pandemic. Vagish reported that, even though he was trying to get through the semester, he was not restricted by any oversight from his university. In addition, he reported some innovative implementation of pedagogies, even though, to him, they were not the major achievement as a research-focused faculty. The lack of correlations between attitude toward context's *constraints* and faculty behavior can also be seen in Xavier response, who initially planned certain activities, but when he realized that "it was very hard to synchronize everyone" he resorted to other modalities. And even though it was "challenging" to him, he made the decision to make students work on activities independently and to ask students to take pictures of their work. His decision was not forced on him by anyone even though the pandemic context had affected his plans.

Another way to interpret how faculty did not report high correlations with context's *constraints* and their behavior is the fact that impact of the pandemic transcended the academic and professional life of faculty to their personal life. Griffin, for example, reported how impactful was missing the human-element in his interaction on his life, both personally and professionally. The requirements, therefore, to teach online during the pandemic could not be seen as constraints anymore. Sophie, reported that her prior life as a graduate student was already stressful, and she had to adapt all the time. For her as fresh graduate who came into a full-time academic position, the situation could not be seen as a constrained one. Sophie also reported that the students themselves were aware of the impact of the pandemic, and they appreciated that their instructors were trying to do their best despite the situation.

Finally, all faculty reported that their universities supported any ideas they had to improve teaching during the pandemic. This is another way to interpret the lack of constraints in the COVID-context. Tanner reported that his university would have supported any initiatives he might have brought to their attention. Mary also said that her university was “incredibly supportive [...] They were fantastic. There are no faculty on this campus who could complain that they didn’t have the support they needed.” Overall, although the pandemic has affected faculty plans, they did not seem to see the response by their universities to be a constraint over their behavior to change.

Finding III: In the EM-context, Group A faculty showed higher *willingness* compared to Group B faculty

The different set of responsibilities that faculty in Group B are expected to do, and be evaluated on, may limit their involvement in curricular change initiatives like the EM integration. Jack made a comparison between his prior role as a tenured professor before leaving academia to go to industry and then came back again as a teaching-focused faculty in a large research university: “I know because I walked that tightrope before.” When Vagish, who is a research-focused faculty (Group B), was asked about talks or initiatives in his department to improve teaching, he laughed and said the following:

“No ... I'm kind of laughing because I think that would be ridiculous ... like that would be funny because the department has no incentive to make teaching good in that way, I feel like, at least at our schools. Yeah, I think they care more about the numbers and how all the numbers are doing, so”

A similar observation was provided by Mary:

“So we are an R2 institution. And we have too many administrators who want us to be an R1. So there's a heavy emphasis on research. The people who are the most research active are the ones who get the most attention. It just is; that's the way it is on our campus. So teaching is not always valued as much as it should be. My position ... so I am at the top of the non-tenure track food chain. So I'm a professor of practice; there's three other levels below me. In effect, I have tenure; I don't have a contract. I basically have a path of what would be equivalent of tenure. But there is an expectation that I do have research—just submitted a National Science Foundation grant, waiting to hear on that. I'm expected to do a paper every year. I usually do two to three papers a year; in fact, had two journal papers published in the spring on COVID-related stuff. I'm working on a conference paper right now. So yeah, and pretty heavy service load as well. So institution focuses a lot on research; the expectation is that I focus on teaching and service, but there is also a heavy research component to it as well.”

Interestingly, this finding here is about faculty's *willingness* to change; it's not about *self-efficacy*. It may sound to be reporting the obvious that teaching-focused faculty (Group A) are more *willing* to adapt, even though research-focused faculty still have the potential to adapt. In fact, in the COVID-context, faculty in Group B have reported innovative implementation of pedagogies (like Vagish) even though they underestimated that effort. This finding may have implication on change initiatives, especially when framed in reference to calls for change that are not attuned to the broad roles that faculty are expected to engage in. Brooke, Alex and Jack all reported multiple attempts to address this issue in the KEEN initiative by telling the organizers that the way the workshops were designed, in terms of length, scope and content, to be targeting teaching-focused faculty. For them, as faculty who are involved in large research universities, this may not resonate with what they do as it would be extremely difficult to follow such demanding implementation. Their suggestions were around providing easy-to-access, small scale and flexible implementation. Their two major concerns were around the time commitment required by such initiatives, and the

language used in describing change, which is resulting in a cult kind of group that research-focused faculty (Group B) may not find themselves willing to adopt easily.

Finding IV: In the EM-context, Group A faculty showed no significant correlations with attitude toward context

For some faculty participants in the EM-context, their interest in integrating the EM did not necessarily always align with the framing of EM provided by KEEN. For example, both Brooke and Alex reported their reservation to the notion of value creation being always associated with economical gain. Yet, they continued their efforts in integrating EM in their work. They also reported that their involvement with KEEN was mainly by transmitting contributions, through workshops and materials to the network, rather than getting input from the workshops. Kaleb reported a similar approach of his university contributing to the network, but also acknowledged the value of interacting with the KEEN community. Some faculty participants, like Robert and Kaleb, shared that there were efforts on their campuses to integrating the EM even before joining the KEEN network. For Mary, she was always interested in ideas around EM, and found a call to participate in a KEEN workshop to be a unique opportunity to be engaged in the activities on her campus.

On some campuses that are part of the KEEN network, there were few faculty who were taking part of the initiative. Some, like Miles, received resistance from some colleagues; yet, that also did not prevent him from continuing to pursue his efforts. Xavier reported a similar lack of interest from faculty in joining social activities and workshops around EM, but that did not prevent him from leading the effort on his campus as part of the core team.

Overall, Group A faculty showed *willingness* to engage in the EM integration efforts without being impacted by the circumstances of the context during change. This finding may have implications on understanding (1) why faculty, especially with a teaching-focused role type, may pursue an effort to implementing change. In addition, and in relation with other findings in this study, (2) how far does this *willingness* go in terms of actually implementing meaningful change, beyond just being inspired by the calls for change and forming intention around it. Another point of interest is about (3) the role that a funding and a coordinating organization, like KEEN, plays in inspiring, leading and supporting this kind of change effort. To attempt to answer these questions, consider Alex's comment when he characterized the presence of the KEEN initiatives on his campus, "the students are even further removed from it. They don't see any of it, I would say." The comment by Alex may point to the importance of the *level of presence* and the *branding* of the integration effort. Alex and Brooke shared sensitivities around this branding, though, because it creates some sort of a culture that some faculty may not be comfortable being part of it. Jack emphasized the importance of *level of support* from the administration in the integration effort; the branding and presence of an outside organization is less relevant.

Teaching-focused faculty always reported interest in improving their teaching and trying new pedagogies, which was associated with awareness of what is involved in curricular change. That interest was shown to be faced with competing values, as reported by some faculty participants, which might have limited their ability to push it forward. More specifically, the interest of teaching-focused faculty showed to be intertwined with personal

and professional interests to have impact on the students. Consider, for example, Connor's comment:

"Yes and no. I'm trying to integrate ... and I'm going to be as fair as I can be ... not EM across the curriculum, I'm motivated to integrate social justice issues and awareness in the curriculum. EML is for me a means to achieve that because I can convince my colleagues that I'm pursuing a route of creation of value for communities, which makes my efforts more universally accepted than it is for me to say, "I'm talking about social justice issues when I brought that up." So my colleague say that's a policy issue; that's not an engineering issue. So I'm using EML as a bridge to raise that type of learning in my courses."

Mary shared her interest in improving her teaching. Despite the fact that university offered incentives, she had "a strong interest in pedagogical research, educational research, so I just wanted to become a better teacher, especially online when there are a lot of challenges." For Kaleb, the EM was how he saw the world, and, to him, there was an alignment between his interest and what KEEN had to offer:

"I think this is a at the most basic it just resonates with how I see the world. I mean my background is design. And even preceding any of this when I came into the college, I think that I came into the college as a professor of design and entrepreneurship, because I saw the coupling of those two and still see the coupling of those two as the fundamental mechanism of value creation. You need both the ability to dream and imagine as well as the ability to deliver to implement and deliver. And I think design and entrepreneurship coupled those two and so that's my perspective on those disciplines, that's my perspective on the world, that's my perspective on engineering. And so I think that I experienced the opportunity to champion entrepreneurship as a welcome extension of the things that I was already trying to champion. So for me it was an opportunity; it's like, "Oh here this is the thing that I almost in many ways it already want to do." It certainly channeled my energies into a particular perspective, so I may not have necessarily said they're going to manifest as me creating this new course, but they would have manifest, and were manifesting in other ways, already."

Willingness to change, therefore, as demonstrated by teaching-faculty did not always mean rallying around a given vision; instead, it seems to be related to a personal interest in having an impact on the students *in a certain way*. Therefore, for this *willingness* to have

fruitful impact, an alignment is needed between the personal interests of the teaching-focused faculty and the integration efforts across the curriculum. An integration effort that does not attend to the personal interest of faculty in what they teach and how they teach it may not be as fruitful. In this regard, support from the administration seems to be needed to build a community of practice and encourage discussion about interests and effective teaching. An external entity, like KEEN, may provide funding and organize support; however, the branding of this effort may not always be appreciated. In order to build on the *willingness* of teaching-faculty to have an impact, an organization of their efforts, supported by the administration, seems to be needed.

Finding V: In both contexts, *willingness for adjusting* was not correlated with *attitude toward context*

This finding overlaps with previous observation, but it was insightful to find that faculty participants, in both contexts, and in both Groups A and B of role types, were *willing to adjust* regardless of the context they were in. This *willingness to adjust* could be explained by faculty participants' motivation to change their behavior. In the EM-context, that was related to their motivation in expanding the engineering perspective of the student. Connor, for example, related that to his upbringing and how it informed his perspectives "as a member of a non-dominant group in engineering." Miles shared how learning new pedagogies keeps him current. Robert mentioned how the ideas he was implementing around e-portfolios, allowing students to build a narrative around their identity, was essential to his role as a

professor. Jack said how he formed a group of colleagues to discuss efforts of integrating EM despite the lack of enough support from the administration.

In the COVID-context, *willingness for adjusting* was related to persistence and bearing responsibility, despite the challenging context of the pandemic. Griffin shared how, despite the missing element of human interactions, he still wanted to provide a meaningful capstone experience to the students. Mary talked about her passion for bringing “universal design principles” to education, and found the COVID-context to be a unique opportunity for that. Vagish cited a “sense of urgency” to be the motivation behind him *willing to adjust* despite the pandemic, so that he could connect with his students.

Overall, faculty participants’, across contexts and across groups, shared moving and powerful statements about why they taught and why they were *willing* to adjust. The implication of this finding is that, any call for change should embrace faculty’s willingness to have an impact on students’ lives. This could be by careful messaging, tapping into the essence of teaching as a profession. Also, sharing insightful examples of attempts of other faculty may be effective in moving change efforts. Faculty seemed to face a tension between *an ability to innovate* and *an accountability toward their tasks* (including research expectations). Earlier in this study, the expanding roles and tasks that are being asked from faculty to take have been highlighted. This does not come without time demands, as have been reported by many participants to be the major barrier for not being able to implement changes. While faculty may be *willing* to adjust, the extent to which their time and resources allow them to do so remains pivotal in implementing change. Accordingly, any calls for change should

consider the time demands on faculty to move from being just *willing* to adjust to actually becoming an active and participating agent for change.

2. Situating the findings in the literature

2.1 Understanding faculty's *planning* behavior during curricular change

In the literature, the two major components of *planning* as a phase in self-regulation are time and effort management. Both components were shown in faculty participants' responses as subthemes under *willingness for planning* and *self-efficacy in planning*. In the EM-context, dedicating time and effort was shown as the level of engagement in the KEEN workshops to integrate the EM and modify the courses. In addition, under *willingness for planning*, allocating time and dedicating effort overlapped with intention formation and achievement motivation in order to plan for change. In the COVID-context, the information that faculty participants were receiving about the spread of the pandemic and their university's responses, despite being limited and confused, were reported to be important in their planning efforts.

The two components of time and effort in planning have been found to be influenced by the perceptions of the task and the perceptions of the context (Pintrich, 2000). Clear contexts are described as ones that provide the same understanding for everyone of "how they are supposed to respond and everyone has the will and ability to respond as expected" (Bowles, Babcock, & McGinn, 2005, p. 4). Furthermore, clear contexts have been described as "strong" because they are well-structured such that the appropriate and required responses are clear: "individual differences become minimal and situational effects

prepotent” (Mischel, 1977, p. 347). Because one of the underlying assumption of self-regulation of the active agency of the individual, a perception of a clear context implies high *self-efficacy in planning* in that context. Conversely, the lack of clear perceptions of the context prohibits the activation of the knowledge about context, and thus influencing the formation of intentions on how to approach a situation in that context (Pintrich, 2000).

However, faculty participants in the EM-context reported the scarce availability of time to make changes. Also, both the quantitative and the qualitative analysis showed no difference between the EM-context and the COVID-context in terms of *willingness for* and *self-efficacy in planning*. Although faculty in the EM-context showed interest in engaging in the KEEN activities, they could not put the time and effort to implement change. In contrast, faculty participants in the COVID context, who had limited time, ended up spending significant amount of time and effort to respond to change. In both contexts, faculty were committed to delivering quality outcome to the students.

One way to situate these findings in the literature is realizing that developing perceptions of the task within the context involves understanding the norms of completing the task, such as format and procedures (Pintrich, 2000); and general knowledge about the practices taking place in that context (Blumenfeld, Mergendoller, & Swarthout, 1987; Doyle, 1983). Hence, “the climate” of the context act as enablers for effective planning. Conversely, the lack of clear perception of the situation in terms of climate (that is, expectation) has been found to deactivate intentions about how to approach the situation (Pintrich & Schunk, 1996). Pintrich (2000) observed that a situation can be misperceived, resulting in activating stereotypical knowledge about the situation. Here, in both contexts, faculty reported a lack

of clarity: in the EM-context due to the large scale of integration effort, and in the COVID-context due to the uncertainty. However, the “norms” during COVID were such that faculty could implement change even though they did not have the time, because everyone was in the same situation, whereas during the EM implementation faculty could not implement change because it was not the norm.

Hence, the importance of having the administration fully embrace a change effort (like an integration effort) so that inconstancies that act as a barrier for implementation can be avoided, while also realizing, as has been found in this study, that change cannot be enforced on faculty if it does not align with their personal interests. In the literature, Zimmerman (1998a) observed extensive anecdotal evidence of similarities between planning activities in various contexts, including student learning as well as experts in music, sports and professional writing. Contexts that induce the motivation for goal setting (Garcia & Pintrich, 1994; Schunk, 1994) tend to provide the space for activity planning (McCombs, 1989; Winne & Hadwin, 1997). Furthermore, time management as a skill in the planning phase has been found to be the most critical amongst all phases affecting motivation for self-regulation (Britton & Tesser, 1991; Zimmerman, Greenberg, & Weinstein, 1994). Constrained contexts prohibit the ability to control and manage time.; if a context is perceived not to allow the management of time, then the ability to plan is not achieved. Furthermore, constrained contexts will have a negative effect on the ability to monitor and adjust to achieve goals (Corno, 1993).

As for the importance of administration support to (1) embracing the integration effort; (2) making it personal to the faculty; and (3) recognizing the limited time faculty have

to change, Zimmerman (1989) observed the reciprocal effect of proactive efforts to plan to pursue a certain goal and the perceived results of this planning. If a context is not supportive to outcomes of planning and initial results, motivation for further regulation will decrease (Marsh, 1990; Pajares & Miller, 1994).

2.2 Understanding faculty's *adjusting* behavior during curricular change

In the literature, *adjusting* in self-regulation is enabled in contexts that provide clear, available and easy-to-understand cues regarding work-related responsibilities. Individuals are willing to adjust behavior when expectations are well-communicated, information are clear and support is existing (Fairweather & Rhoads, 1995). Also, it is reported that individuals will engage in adjusting efforts when the context enables both self-control and self-observation of the results of their performance (Schunk, 1982; Meichenbaum, 1977; Zimmerman, 2000). However, the findings from this study suggest that faculty participants showed *willingness for adjusting* irrespective of the context. They all provided powerful and emotional responses in moving ways when describing their interest in making an impact on students' learning. This could be explained by faculty's unique profession expectations where personal and professional lives and goals often overlap.

Although in the literature it is reported that providing uniformal sources of information with consistent communication will stimulate change and resolve issues faculty may have regarding roles and level of autonomy, faculty participants in this study showed motivation to change behavior with persistence and willingness to bear responsibility, especially during the pandemic context with all its uncertainties. Often times, faculty

participants sought to change the context by establishing communications with colleagues and students. In the literature, providing a shared, consistent understanding of the context (in the EM-context by understanding the relationship between the local change in the course and the larger curriculum, and in the COVID-context by understanding the stressful impact of the rapid, unexpected change) has been shown to involve support from peers in the program and the administration (e.g., Bacharach & Bamberger, 2007). This may have not been the case for many participants in both contexts of this study.

At the same time, faculty reported in both contexts that they were not constrained. Contexts that are less constrained enable the experimenting with new ideas (Pintrich, 2000) by providing more opportunities to control behavior as well as to control the context (Hofer et al., 1998; Zimmerman, 1998a). Faculty felt empowered to *adjust* in response to change (Lucas, 1994; Tucker, 1992) when they were allowed to be creative and have support to their professional needs (Guskin, 1981). In comparison, contexts that are closely monitored with top-down control and with strict guidelines of implementation to be adhered may negatively influence faculty's *self-efficacy in adjusting*.

2.3 Understanding faculty's *reflecting* behavior during curricular change

In the literature, *reflecting* in self-regulation is enabled in contexts that allow self-observation, experimentation and evaluation. Such contexts allow self-monitoring and induce the ability to compare between contexts. Clarity of contexts encourages contextual awareness. Because teaching, as a profession, is built around field experiences (Zeichner & Liston, 1987; Cliff, Houston & Prignach, 1990; Calderhead & Gates, 1993, Smith & Hatton, 1993; Loughran,

1996), the clarity of the context amplifies the understanding of the variability of the context (Weiss & Adler, 1984). Conversely, the lack of clarity impacts the understanding of the context. Boud & Walker (1998) argued that reflecting is a “highly context-specific” activity (p. 191) suggesting that an impactful reflection should take into account all the aspects of the context in order for it to be influential. Interestingly, in both contexts, participants reported lack of clarity, and while they showed *willingness for reflecting* in both contexts, participant did not report high *self-efficacy* in reflecting.

The clarity of context gives cues for compatible work expectations (Meyer et al., 2010), thus enabling faculty to seek structured ways for effectively incorporating findings of educational research and interventions from other settings in assessing their work (Angelo, 1991; Cross 1998). However, while faculty reported effort in collecting data, most implementations of reflection were not built on diligent reflective strategies and were generally reported as informal efforts and discussions with peers. Because in the framing of this study *reflecting* is described as a monitoring phase in the self-regulation process which follows an action behavior (i.e., *adjusting*), the adaptation cycle cannot be reactivated if reflection results were not used for future planning. Furthermore, clear contexts that allow the operationalization of reflecting *uniformly* after action are conducive for predictable *reflecting* (Mischel, 1973). In curricular change, clear contexts that provide compatible sources of information, across time, with clear guidelines and systematic support during the implementation of change will encourage the self-evaluation of faculty of their performance. Conversely, the lack of clarity limits the ability to monitor one self's performance in reference to a standard.

Two major barriers for faculty's effective implementation of reflective practice have been: (1) the lack of time availability; and (2) the lack of awareness of different reflective strategies. Although faculty did not report constraints on their activities, time continued to be a major barrier. As such, a context with limited external regulations that allows faculty to implement curricular changes with higher levels of autonomy is a context that encourages the self-monitoring and the self-evaluation of performance. However, with limits on time, the ability of a faculty to make individual decisions and act based on them (Peters et al., 1982) caused limited options for faculty to pursue courses of action. Zimmerman (2008) observed that for individuals with specialized expertise, like faculty, the existence of such a constraint has a significant relationship with experts' willingness to show voluntary behavior. For such individuals, the constraint that characterizes the context prohibit monitoring the situation in order to pursue a suitable course of action (Withey, Gellatly, & Annett, 2005).

Overall, faculty did not seem to use reflective strategies to act based on lessons learned from previous implementations. Assessing the consequences of a new implementation is a process of *reflecting* (Weiner, 1986; Zimmerman & Kitsantas, 1997). Faculty who try something new for the first time would develop an understanding of the consequences of their implementation (Bekki et al., 2017). *Reflecting* is enabled by the ability to anticipate consequences and compare actual outcomes with expectations. Faculty had the opportunity to reflect on implementations, especially that they were not constrained by negative consequences or threats of negative outcome (Meyer et al., 2010, Meyer, Dalal, & Bonaccio, 2009). However, what was missing is putting the time in effective reflective strategies to enable another cycle of self-regulation.

3. Study contributions

3.1 Understanding faculty adaptability during change

The study contributes to our understanding of engineering faculty adaptability in different curricular change contexts. Faculty are being asked to engage in a variety of activities that are changing in nature and scope (“ASEE”, 2012; “NAE”, 2004; “PCAST”, 2012). Previous studies of change in engineering education did not account for the full range of behaviors that faculty are expected to contribute in order for successful implementation of change (Borrego, Froyd, & Hall, 2010; “NRC”, 2012; Prince & Felder, 2006). Challenges exist in implementation of effective strategies, including adoption and scaling-up, where faculty emerge as central change agents in affecting change in the college education experience (Bekki et al., 2017; Borrego & Henderson, 2014). Faculty members tend to value autonomy; self-driven innovations (vs. administrative-driven); inclusive opportunities for feedback; community; recognition and efficacy (Bolman & Deal, 1991; Borrego & Henderson, 2014; Guerra et al., 2014). Calls for change in engineering education continue to ask of faculty to master an expanded set of responsibilities. Role theory contrasts between fixed, formalized tasks, which can be evaluated in terms of proficiency behavior, and emergent work roles, which can be evaluated in terms of adaptive behavior (Ilgen & Hollenbeck, 1991). In this framing, the nature of work roles is linked with the contexts in which they exist (Griffin, Neal, & Parker, 2007). Contexts shape the behavior that is valued in the organization for effective work (Scott & Davis 2015; Thomson, 2003). In this study, two contexts are examined to understand their effect on adaptability: one that is characterized by *prescribed interdependence*, where faculty engage in curricular change activities that are embedded in a

larger network of colleagues who are engaged in similar activities; and the other is characterized by *emergent uncertainty*, where faculty engage in curricular change that is not formalized. This study showed that faculty adaptability does not happen in isolation and is largely influenced by the context. Although faculty showed no difference to being willing to adjust their behavior to the context they are in, they were influenced by the context. Furthermore, the study showed difference in adaptability between teaching- and research-focused faculty, while also indicating to the willingness for the two groups to deliver high-quality teaching. Also, this study that faculty participants were not constrained by either context to adjust their behavior.

3.2 Instrument development

The importance of establishing norms during change was found to be important to provide clarity. In previous research, perceptions by the individual of team supportiveness was shown to be significantly related to adaptability (Griffin, et al., 2007). Findings from role theory suggest that an individual will behave in ways that support the social entity they work with if they recognize a bond of identity (Katz & Kahn, 1978). Other research on teaming suggests that perception of support from the team to a team member contributes to team effectiveness (Colquitt, Noe, & Jackson, 2002). In this research, the instrument developed to study faculty adaptability and their attitude toward context is a significant contribution given the lack of this measure in academic settings, as most of the literature on the topic comes from organizational literature.

3.3 Uniqueness of faculty in academic organization

In the organization literature, a supportive organization will likely contribute to the individual effectiveness (Eisenberger, Fasolo & Davis-LaMastro, 1990). Perceptions by the individual of organizational commitment was shown to be significantly related to adaptability (Griffin, et al., 2007). Given the setting of this study, however, faculty in academia may behave differently as their commitment may be higher to the research field and the community more than to the university (as an organization). Becker & Kerman (2003) observed that commitment to the organization may predict organizational focus but not courtesy in role performance. Therefore, This study fills an important gap studying faculty adaptability given their unique attributions.

3.4 Contributions to understanding self-regulation in social contexts

In this study, the development of the conceptual framework and the operationalization of items attempt to capture elements of socially shared regulation. For example, the findings by Nicol & Macfarlane-Dick (2006) suggest that individuals take proactive role in assessing their work by utilizing good feedback practices. The good feedback practices include, for example, clarifying good performance expectations (planning); encouraging dialogue around learning (adjusting); and developing of self-assessment (reflecting). Consider *planning* as an example. As discussed before, models for *planning* differ in the degree to which goals in planning are oriented toward the individual's desire for achievement or, alternatively, in response to the contextual factors where the individual functions. Although all models assume planning to be a function of both individual's attributes and contextual factors, the models differ in their

level of emphasis on either one of the two variables. The common areas of regulation are the traditional areas of psychological functioning: cognition, motivation and behavior (Snow, Corno, & Jackson, 1996). However, Pintrich (2000) suggested a fourth area of regulation, *context*. In their work, faculty are regulating both themselves and the context within which they function.

Similarly, the findings from this study show *adjusting* to take the form of contextual control. An example is *adjusting* that takes the form of help-seeking (Newman, 1991, 1994), where the behavior is directed toward social interaction as a way for contextual control (Ryan & Pintrich, 1997). When faculty engage in curricular change efforts, they engage with peers in the development, implementation and evaluation phases. Faculty seek affirmation during the *development* phase in an effort to resolve the tension they experience between “competing values,” tension between the autonomy in creative implementation of change and the accountability to the sponsors of change and to the students (Quinn, 1988; Quinn et al., 1990). As a matter of fact, Tiberius (1995) described the process as a “quiet revolution in teaching improvement programs” when faculty transition from shaping individual performances to dynamic interaction with peers. During *implementation*, faculty value social contexts that motivate a sense of ownership and a sense of support (Guskin, 1981). Research has also shown that faculty can establish an increased motivation to adjust when there is a clear shared perception of the reward system (Cochran, 1989; Gray, Froh, & Diamond, 1992). In the *evaluation*, faculty feel empowered when administration gives attention to their efforts (Stark & Briggs, 1998).

In discussing *reflecting*, the need for heightened levels of awareness of both the task being undertaken and the context within which it takes place is reported in this study to be a major component of faculty behavior. An environment that enables self-observation (Zimmerman & Martinez-Pons, 1986) and self-experimentation (Zimmerman, 1998a, 2000) during the activity is usually an environment that induces effective self-monitoring. Stark et al. (1988) found that one of four ways that faculty pursue to assess their teaching is to seek the opinion of peer faculty to judge the course. Consulting faculty peers in reviews of classes has been found to be a successful model (Hutchings, 1995; 1996). In addition, faculty can consult with an outside unit (like an evaluation office on campus) or directing an evaluation session with another faculty member (Tiberius, 1995).

Overall, the findings in this study add to the development of socially shared regulation, as discussed by Panadero & Järvelä, (2015). Their work points to the characteristics of socially shared regulation. Capturing the different levels of social regulation involve making distinctions between socially shared regulation vs. co-regulation). While such fine delineation is beyond the scope of this study, it will certainly help in interpreting the findings in this study. More specifically, the purpose of the qualitative phase of the study was to *explore* the process of adaptation during change, where the central phenomenon was adaptation *as a process* that is shaped by external forces during curricular change.

4. Practical implications for this study and future work

- The findings from this study point to the importance of **administration support** during curricular change. Administration support provides clarity to the context, and,

hence, enable the adaptation cycle of faculty. Furthermore, administration support helps in establishing the norms, without posing any constraints, by enabling a culture that encourages and rewards experimentation of new ideas. Administration support *should build on faculty's demonstrated willingness to change*, regardless of role-type, as long as the support helps in aligning the change goals with the personal and professional interests of faculty.

- **Time** has been shown to be a major barrier against faculty's effort to engage in and implement curricular change. This finding has been consistent across contexts and role-types. Although faculty show willingness to change their behavior, the expanded roles and responsibilities that they are asked to take add more demands on their work time. Therefore, any future curricular change efforts, which consciously seek to engage faculty as active agents for change, should be both considerate and creative in developing interventions that seriously take time demands on faculty into consideration. One effective example that was shared in this study was the utilization of communities of practice. In both contexts, during the EM-integration and in the COVID-contexts, supportive communities of practice was an example of time-cognizant yet effective way to discuss learning approaches. Although some faculty may decide not to engage in such communities, alternative ways that build on *faculty's demonstrated willingness to change* should be studied and implemented.
- **Cultivating a culture of reflective practice** seems to be the missing piece in sustaining adaptation cycles, as faculty reported lack of utilization of effective reflective strategies as well as lack of time to build on reflection. Reflecting, as a

process that requires *acting* on learned lessons, is essential to enacting change; yet, it seems to be underutilized, Figure 12. Reflecting, a reported under-utilized step, is essential to initiating a new cycle of adaptation.. Creative ways, supported by research, are needed to help faculty utilize effective reflective strategies, that are both cognizant of time-demands on faculty and that build on *faculty's demonstrated willingness to change*.

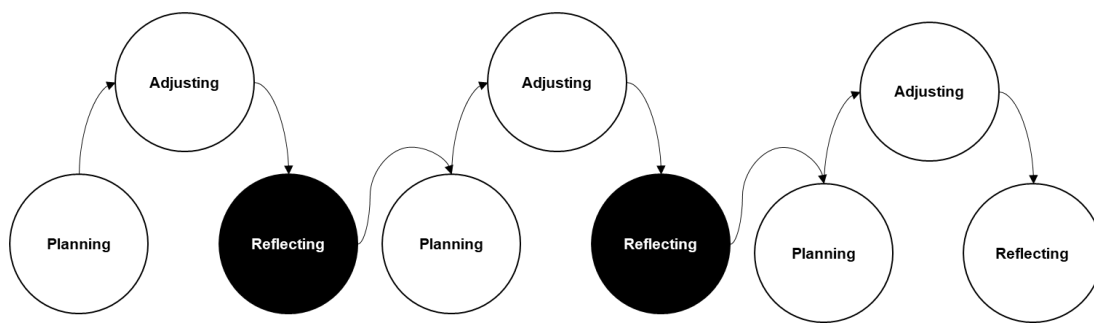


Figure 12. Reflecting, a reported under-utilized step, is essential to initiating a new cycle of adaptation.

In addition to previously highlighted potential directions for future work, including overcoming some of the highlighted limitations, the following directions for future work are envisioned:

- The richness of the collected qualitative data from the interviews suggests that there is a need to reexamine the interviews in a new light, specifically addressing the question of how contexts are conceptualized. One of the underpinning assumptions of this work has been that integrating the EM was a context that has some situational strengths along the four dimensions conceptualization framework. Similarly, the

COVID context was assumed to have different situational strengths. However, as the findings from this study suggest, the way contexts were conceptualized need to be reexamined. More specifically, what are the collective qualities that trigger change? How change is initiated, catalyzed, and sustained? And why certain efforts are more successful than others? In addition, and as discussed in depth, the role of the “administration” was found to be essential. But what constitutes the administrative role during the process of change? And how is this role conceived of by both faculty and other stakeholders? There are traces of ways to answer these questions in the collected interviews, and building on these findings, there are promising directions for future work.

- Another way to explain the findings, after the QUAN-qual sequence, is to go back to analyze certain items in the collected quantitative data to help explaining certain outcomes and point to future directions. For example, the responses to individual items around the “significance of change” of each group needs to be reexamined. Similarly, how different groups responded to the notion of being “closely monitored” with directions to be “strictly followed” needs to be reexamined in the new light provided by the qualitative findings. The future analysis may point to the need to explore the role of the administration and the strength of top-down control in academia as a unique context of organizations.
- The potential of using the findings from this study to develop a workshop to introduce and cultivate the idea of being adaptable is also promising. As illustrated in the literature, there continues to be a tension whether adaptability can be learned in

domain-specific or domain-general contexts. While this can be a promising area for future research, an important step in the process is the cultivating of reflective practice in time-considerate yet impactful ways. Reflective practice, its tools and efficacy, seem to be an important requirement in adaptable behavior.

- This work can also be extended and shared in communities beyond academia. As discussed in the literature, most of ideas about adaptability come from the organizational literature; however, in order to fill the gaps identified earlier, potential outlets that extend beyond the engineering education community may benefit from the findings of this study.

CHAPTER 7

CONCLUSION

Faculty are being asked to engage in a variety of activities that are changing in nature and scope. In this study, faculty adaptability was conceptualized using a modified self-regulation that incorporated *willingness* to engage in each phase of the adaptation cycle as self-regulation: *planning, adjusting and reflecting*. Because faculty members tend to value autonomy; self-driven innovations (vs. administrative-driven); inclusive opportunities for feedback; community; recognition and efficacy, *willingness* to engage in curricular change is important. Faculty showed *willingness* to adjust regardless of context, which is a quality that future calls for change should embrace. However, in order to enable the behavior for change, administration support is needed to provide clear contexts with consistent norms and expectations while aligning faculty's personal motivations with calls for change. Also, time constraints proved to be a major barrier to engage in adaptation. In the two contexts of the study, faculty tended to underutilize effective reflective practice, beyond collecting data and having informal discussions with colleagues. Previous studies of change in engineering education did not account for the full range of behaviors that faculty are expected to contribute in order for successful implementation of change. Challenges exist in the implementation of effective strategies, including adoption and scaling-up, where faculty emerge as central change agents in affecting change. This work contributes to the field by shedding light on faculty adaptation during curricular change, filling an important gap of the behavior of faculty as independent agents who value creativity in the unique setting of academic organization.

REFERENCES

- “ABET” (2020). *Setting The Standard Worldwide*. Accreditation Board for Engineering and Technology. Retrieved from <https://www.abet.org/accreditation/>
- Agresti, A. (2009). *Statistical methods for the social sciences*. Prentice Hall.
- Ajzen, I. (1988). *Attitudes, personality, and behavior*. Chicago: Dorsey Press.
- Ajzen, I. (1991). A theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179-211.
- Ali, H., & Abhyankar, R., & Brunhaver, S. R., & Bekki, J. M., & Jordan, S. S., & Lande, M. (2020, June), *An Additive Innovation-Based Faculty Development Program: Methods for Case Study Research* Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual On line . 10.18260/1-2--34102
- Ali, H., & McKenna, A. F. (2020, June), *Representations Between Engineering Design and Engineering Analysis* Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual On line . 10.18260/1-2—35145
- Allen, N. J., & Meyer, J. P. (1990). The measurement and antecedents of affective, continuance and normative commitment to the organization. *Journal of occupational psychology*, 63(1), 1-18.
- Allport, G. W. (1935). Attitudes. In C. Murchison (Ed.), *A handbook of social psychology* (pp. 798–844). London: Oxford University Press.
- Allworth, E., & Hesketh, B. (1999). Construct-oriented biodata: Capturing change-related and contextually relevant future performance. *International Journal of Selection and Assessment*, 7: 97-111.
- Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology*, 84, 261-271.
- Amundsen, C., & Wilson, M. (2012). Are we asking the right questions?: A conceptual review of the educational development literature in higher education. *Review of Educational Research*, 82(1), 90–126. doi: 10.3102/0034654312438409
- Andersen, M. L. (1987). Changing the curriculum in higher education. *Signs: Journal of Women in Culture and Society*, 12(2), 222-254.
- Anderson, N. R., & West, M. A. (1998). Measuring climate for work group innovation: development and validation of the team climate inventory. *Journal of Organizational Behavior*:

The International Journal of Industrial, Occupational and Organizational Psychology and Behavior, 19(3), 235-258.

Angelo, T. A. (1995). Improving classroom assessment to improve learning: Guidelines from research and practice. *Assessment Update*, 7(6), 1-2.

“ASEE” American Society for Engineering Education (ASEE) (2012). *Innovation with impact: Creating a culture for scholarly and systematic innovation in engineering education*. Washington, DC.

“ASEE” (2020). *COVID-19 & engineering education: An interim report on the community response to the pandemic and racial justice*. The Engineering Education Community’s Response. Washington, DC: American Society for Engineering Education.

Astin, A. W. (1979). Student-oriented management: A proposal for change. In *Evaluating educational quality: A conference summary* (pp. 3-18). Washington, DC: Council on Postsecondary Accreditation.

Axelrod, J. (1968) *Curricular Change: A Model for Analysis*. Berkeley, Calif.: Center for Research and Development in Higher Education, University of California.

Azevedo, R. (2009). Theoretical, conceptual, methodological, and instructional issues in research on metacognition and self-regulated learning: A discussion. *Metacognition and Learning*, 4(1), 87-95.

Baard, S. K., Rench, T. A., & Kozlowski, S. W. (2014). Performance adaptation: A theoretical integration and review. *Journal of Management*, 40(1), 48-99.

Bacharach, S. B., & Bamberger, P. A. (2007). 9/11 and New York City firefighters’ post hoc unit support and control climates: A context theory of the consequences of involvement in traumatic work-related events. *Academy of Management Journal*, 50: 849-868.

Baker, L. (1979). Comprehension monitoring: Identifying and coping with text confusions. *Journal of Reading Behavior*, 11, 365-374.

Baker, L. (1989). Metacognition, comprehension monitoring, and the adult reader. *Educational Psychology Review*, 1, 3-38.

Bandura, A. (1986). *Social foundations of thought and action: A social theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W. H. Freeman.

Banta, T. W., & Schneider, J. A. (1988). Using faculty-developed exit examinations to evaluate academic programs. *The Journal of Higher Education*, 59(1), 69-83.

- Becker, P. H. (1993). Common pitfalls in published grounded theory research. *Qualitative Health Research, 3*(2), 254-260.
- Bekki, J., Ayela-Uwangué, A., Brunhaver, S., Kellam, N., Lande, M., & McKenna, A. (2017, June). I want to try that too! Development of a conceptual framework for interventions that encourage pedagogical risk taking among faculty. In *ASEE Annual Conference and Exposition, Conference Proceedings*.
- Bekki, J. M., Huerta, M., London, J. S., Melton, D., Vigeant, M., & Williams, J. M. (2018). Opinion: Why EM? The Potential Benefits of Instilling an Entrepreneurial Mindset. *Advances in Engineering Education, 7*(1).
- Bergquist, William H., Gould, R. H., & Greenberg, E. M. (1981) *Designing Undergraduate Education. A Systematic Guide*. San Francisco: Jossey-Bass.
- Besterfield-Sacre, M., Cox, M. F., Borrego, M., Beddoes, K., & Zhu, J. (2014). Changing engineering education: Views of US faculty, chairs, and deans. *Journal of Engineering Education, 103*(2), 193-219
- Birdi, K., Clegg, C., Patterson, M., Robinson, A., Stride, C. B., Wall, T. D., & Wood, S. J. (2008). The impact of human resource and operational management practices on company productivity: A longitudinal study. *Personnel Psychology, 61*: 467-501.
- Blumenfeld, P., Mergendauer, J., & Swarthout, D. (1987). Task as a heuristic for understanding student learning and motivation. *Journal of Curriculum Studies, 19*, 135-148.
- Blumenfeld, P., Soloway, E., Marx, R., Krajcik, J., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist, 26*, 369-398.
- Blustein, D. L., Phillips, S. D., Jobin-Davis, K., Finkelberg, S. L., & Roarke, A. E. (1997). A theory-building investigation of the school-to-work transition. *The Counseling Psychologist, 25*(3), 364-402.
- Boekaerts, M. (2011). "Emotions, emotion regulation, and self-regulation of learning," in *Handbook of Self-Regulation of Learning and Performance*, eds B. J. Zimmerman and D. H. Schunk (New York, NY: Routledge), 408–425.
- Boekaerts, M. & Cascallar, E. (2006). How far have we moved toward the integration of theory and practice in self-regulation? *Educ. Psychol. Rev.* 18, 199–210. doi: 10.1007/s10648-006-9013-4

- Bolman, L. G., & Deal, T. E. (1991). Leadership and management effectiveness: A multi-frame, multi sector analysis. *Human Resource Management, 30*(4), 509–34.
- Bonnet, S., Rivera, R., & Zimmerman, B. J. (1997, May). Improving asthma management by focusing on families' self-regulatory phase. Poster presented at the annual meeting of the American Thoracic Society, San Francisco, CA.
- Borrego, M. (2007). Conceptual difficulties experienced by engineering faculty becoming engineering education researchers. *Journal of Engineering Education, 96*(2), 91–102.
- Borrego, M. (2007). Development of engineering education as a rigorous discipline: A study of the publication patterns of four coalitions. *Journal of Engineering Education, 96*(1), 5-18.
- Borrego, M., Froyd, J. E., & Hall, T. S. (2010). Diffusion of engineering education innovations: A survey of awareness and adoption rates in U.S engineering departments. *Journal of Engineering Education, 99*(3), 185–207.
- Borrego, M., & Henderson, C. (2014). Increasing the use of evidence-based teaching in STEM higher education: A comparison of eight change strategies. *Journal of Engineering Education, 103*(2), 220-252.
- Boud, D., & Walker, D. (1998). Promoting reflection in professional courses: The challenge of context. *Studies in higher education, 23*(2), 191-206.
- Bowles, H. R., Babcock, L., & McGinn, K. L. 2005. Constraints and triggers: Situational mechanics of gender in negotiation. *Journal of Personality and Social Psychology, 89*: 951-965.
- Boyer, E. (1987). *College: The Undergraduate Experience in America*. New York; Harper & Row.
- Britton, B. K., & Tesser, A. (1991). Effects of time-management practices on college grades. *Journal of educational psychology, 83*(3), 405.
- Brown, A. L. (1997). Transforming schools into communities of thinking and learning about serious matters. *American Psychologist, 52*, 399-413.
- Burke, C. S., Stagl, K. C., Salas, E., Pierce, L., & Kendall, D. (2006). Understanding team adaptation: A conceptual analysis and model. *Journal of Applied Psychology, 91*: 1189-1207.
- Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research, 65*, 245-281.
- Calderhead, J. & Gates, P. (1993) *Conceptualizing reflection in teacher development*. London: Falmer Press.

- Cantwell, R. H., & Moore, P. J. (1996). The development of measures of individual differences in self-regulatory control and their relationship to academic performance. *Contemporary Educational Psychology, 21*(4), 500–517.
- Caracelli, V. J., & Greene, J. C. (1993). Data analysis strategies for mixed-method evaluation designs. *Educational evaluation and policy analysis, 15*(2), 195-207.
- Charmaz, K. (2000). Grounded theory: Objectivist and constructivist methods. In N. K. Denzin, & Y. S. Lincoln, *Handbook of qualitative research (2nd Ed.)* (pp. 509-535). Thousand Oaks, CA: Sage.
- Chan, D. (1998). Functional relationships among constructs in the same content domain at different levels of analysis: A typology of composition models. *Journal of Applied Psychology, 83*: 234-246.
- Chan, D. (2000). Understanding adaptation to changes in the work environment: Integrating individual difference and learning perspectives. *Research in Personnel and Human Resources Management, 18*: 1-42.
- Clark, B. R. (1983). *The Higher Education System: Academic Organization in Cross-National Perspective*. Berkeley: Univ. of California Press.
- Clark-Ibanez, M. (2004). Framing the social world with photo-elicitation interviews. *American behavioral scientist, 47*(12), 1507-1527.
- Clark, M. C., Froyd, J., Merton, P., & Richardson, J. (2004). The evolution of curricular change models within the foundation coalition. *Journal of Engineering Education, 93*(1), 37-47.
- Clark, M. E., & Wawrytko, S.A. (1990). *Rethinking the Curriculum: Toward an Integrated, Interdisciplinary College Education*. New York: Greenwood Press.
- Cliff, R. T., Houston, R. W., & Prignach, M. C. (1990) Encouraging reflective practice in education: an analysis of issues and programs. New York: Teachers College Press.
- Condoor, S., & Mcquilling, M. (2009). Incorporating an Entrepreneurial Mindset in Freshman Engineering Students. In *Proceedings of the 2009 American Society for Engineering Education (ASEE) Annual Conference and Exposition*.
- Conrad, C. F., & Pratt, A. M. (1983). Making decisions about the curriculum: From metaphor to model. *The Journal of Higher Education, 54*(1), 16-30.

- Corno, L. (1989). Self-regulated learning: A volitional analysis. In B. 3. Zimmerman & D. H. Schunk, (Eds.), *Self-regulated learning and academic achievement: Theory, research and practice* (pp. 111-141). New York: Springer-Verlag.
- Corno, L. (1993). The best-laid plans: Modern conceptions of volition and educational research. *Educational researcher*, 22(2), 14-22.
- Cochran, L. H. (1989). *Administrative Commitment to Teaching*. Cape Girardeau, MO: Step-Up Inc.
- Copeland, A. J.; Agosto, D. E. (2012). Diagrams and relational maps: The use of graphic elicitation techniques with interviewing for data collection, analysis, and display. *International Journal of Qualitative Methods*, 11(5), 513-533.
- Costin, F., Greenough, W. T., & Menges, R. J. (1971). Student ratings of college teaching: Reliability, validity, and usefulness. *Review of Educational Research*, 41(5), 511-535.
- Crawley, E. F. (2001). *The CDIO syllabus: a statement of goals for undergraduate engineering education* (No. 36). Cambridge, MA: Massachusetts Institute of Technology.
- Creswell, J. W. (2008). *Educational research: Planning, conducting, and evaluating quantitative* (3rd ed.). Upper Saddle River, NJ: Prentice Hall.
- Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage publications.
- Cronshaw, S. F., & Jethmalani, S. (2005). The structure of workplace adaptive skill in a career inexperienced group. *Journal of Vocational Behavior*, 66: 45-65.
- Cross, K. P. (1998). *What Do We Know about Students' Learning and How Do We Know It?* Paper presented at the American Association of Higher Education's 1998 National Conference on Higher Education, Atlanta, GA.
- Cross, K. P. (2005). *On college teaching*. Berkeley, CA: Center for Studies in Higher Education, University of California Berkeley.
- Dancy, M., & Henderson, C. (2010). Pedagogical practices and instructional change of physics faculty. *American Journal of Physics*, 78(10), 1056-1063.
- Davis, R. H., Strand, R., Alexander, L. T., & Hussain, M. N. (1982). The impact of organizational and innovator variables on instructional innovation in higher education. *The Journal of Higher Education*, 53(5), 568-586.
- Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*. Boston, MA: D.C. Heath and Company.

- Dey, I. (1993). *Qualitative data analysis: A user-friendly guide for social scientists*. London: Routledge.
- Diamond, R. M. (2008). *Designing and assessing courses and curricula: A practical guide* (3rd ed.). San Francisco: Jossey-Bass.
- Donald, J. G. (2002). *Learning to Think: Disciplinary Perspectives*. San Francisco, CA: The Jossey-Bass Higher and Adult Education Series.
- Douglas, E.; Lande, M.; Jordan, S.; Bumbaco, A. (2015). Artifact Elicitation as a Method of Qualitative Inquiry in Engineering Education. *2015 ASEE Annual Conference & Exposition*.
- Driskell, J. E., Goodwin, G. F., Salas, E., & O'Shea, P. G. (2006). What makes a good team player? Personality and team effectiveness. *Group Dynamics: Theory, Research, and Practice*, 10: 249-271.
- Doyle, W. (1983). Academic work. *Review of Educational Research*, 53, 159-199.
- Dressel, P. L. (1965a). A look at new curriculum models: For undergraduate education. *The Journal of Higher Education*, 36(2), 89-96.
- Dressel, P. L. (1965b). The Need for Curriculum Review: Courses, Quality, and Costs. *The Journal of Higher Education*, 36(8), 443-448.
- Dressel, P. L. (1966). Specific points of attack in curriculum and course revision. *The Journal of Educational Research*, 59(7), 310-314.
- Dressel, P. L. (1971). *College and university curriculum*. Berkeley, CA: McCutchan Publishing Corporation.
- Dressel, P. L. (1976). *Handbook of academic evaluation*. San Francisco: Jossey-Bass.
- Dressel, P. L. (1980). *Improving Degree Programs: A Guide to Curriculum Development, Administration, and Review*. San Francisco: Jossey-Bass.
- Dressel, P. L., & DeLisle, F. H. (1970). *Undergraduate Curriculum Trends*. Washington, DC: American Council on Education.
- Dweck, C. S. (2008). *Mindset: The new psychology of success*. Random House Digital, Inc..
- Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, 95, 256-273.

- Dym, C., Agogino, A., Eris, O., Frey, D., & Leifer, L. (2005). Engineering design thinking, teaching, and learning. *Journal of Engineering Education*, 94(1), 103--120.
- Edmonds, T., & Chua, M. (2017, October). Aspects that influence curricular change capacity: Characterizing the transferability, openness, and literacy of individual changemakers. In *2017 IEEE Frontiers in Education Conference (FIE)* (pp. 1-4). IEEE.
- EFIC (n.d.). Engineering Faculty Impact Collaborative (EFIC). ASU: Engineering, Entrepreneurship + Innovation. <https://entrepreneurship.engineering.asu.edu/efic-think-tanks-faculty-mentorship/>
- Eisner, E. W., & Valiance, E. C. (Eds.) (1974). *Conflicting Conceptions of Curriculum*. Berkeley, CA: McCutchau.
- Elliot, A. J. (1997). Integrating the "classic" and "contemporary" approaches to achievement motivation: A hierarchical model of approach and avoidance achievement motivation. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement*. (Vol. 10, pp. 143-179). Greenwich, CT: JAI Press.
- Fairweather, J. S., & Rhoads, R. A. (1995). Teaching and the faculty role: Enhancing the commitment to instruction in American colleges and universities. *Educational Evaluation and Policy Analysis*, 17(2), 179-194.
- Felder, R.M. (2004). Changing times and paradigms. *Journal of Chemical Engineering Education*, 38(1), 32--33.
- Felder, R.; Brent, R.; & Prince, M. (2011) "Engineering Instructional Development: Programs, Best Practices, and Recommendations," *Journal of Engineering Education*, 100 (1), p. 89--122.
- Flick, U. (2006). *An introduction to qualitative research* (3rd ed.). London, UK: Sage.
- Fry, C., & Van Treuren, K. (2016). Encouraging Student Innovation in a Freshman-Level Computer Science Course. In *Proceedings of the 2016 American Society for Engineering Education (ASEE) Annual Conference*.
- Geertz, C. (1974). From the native's point of view: On the nature of anthropological understanding. *Bulletin of the American Academy of Arts and Sciences*, 28(1), 26--45.
- Gibbs, G. (2007). Analysing aualitative data. In U. F. (Ed.), *The Sage qualitative research kit*. London, UK: Sage.
- Gerhart, A.L., Carpenter, D.D., Fletcher, R.W., & Meyer, E.G. (2014). Combining discipline-specific introduction to engineering courses into a single multi-discipline course to foster the

- entrepreneurial mindset with entrepreneurially minded learning. In *Proceedings of the 2014 American Society for Engineering Education (ASEE) Annual Conference*.
- Glaser, B. G. (1978). *Theoretical Sensitivity*. Mill Valley, CA: Sociology Press.
- Glaser, B. G., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. New York: Aldine.
- Glesne, C. (2016). *Becoming qualitative researchers: An introduction*. Boston: Pearson.
- Greene, J. A., & Azevedo, R. (2007). A theoretical review of Winne and Hadwin's model of self-regulated learning: New perspectives and directions. *Review of educational research*, 77(3), 334-372.
- Griffin, B., & Hesketh, B. (2003). Adaptable behaviours for successful work and career adjustment. *Australian Journal of Psychology*, 55: 65-73.
- Griffin, M. A., Neal, A., & Parker, S. K. (2007). A new model of work role performance: Positive behavior in uncertain and interdependent contexts. *Academy of Management Journal*, 50: 327-347.
- Garcia, T., & Pintrich, P. R. (1994). Regulating motivation and cognition in the classroom: The role of self-schemas and self-regulatory strategies. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 127-153). Hillsdale, NJ: Erlbaum.
- Gollwitzer, P. (1996). The volitional benefits of planning. In P. Gollwitzer & J. Bargh (Eds.), *The psychology of action: Linking cognition and motivation to behavior* (pp. 287-312). New York: Guilford.
- Graham, R. (2018). *The global state of the art in engineering education*. Cambridge, MA: Massachusetts Institute of Technology (MIT).
- Grinter, L. (1955). *Report of the Committee on Evaluation of Engineering Education*. Journal of Engineering Education, p. 25-60.
- Gray, P., Froh, R., & Diamond, R. (1992). *A national study of research: On the balance between research and undergraduate teaching*. Syracuse, NT: Center for Instructional Development.
- Guerra, A. (2017). Integration of sustainability in engineering education. *International Journal of Sustainability in Higher Education*.
- Guerra, R. C. C., Smith, K. A., McKenna, A. F., Swan, C., Korte, R., Jordan, S., ... & MacNeal, R. (2014, October). Innovation corps for learning: Evidence-based entrepreneurship™ to

- improve (STEM) education. In *2014 IEEE Frontiers in Education Conference (FIE) Proceedings* (pp. 1-5). IEEE.
- Guskin, A. E. (1981). *The Administrator's Role in Effective Teaching*. San Francisco: Jossey-Bass.
- Hall, E. T. (1989). *Beyond culture*. Anchor.
- Harackiewicz, J. M., Barron, K. E., & Elliot, A. J. (1998). Rethinking achievement goals: When are they adaptive for college students and why? *Educational Psychologist*, *33*, 1-21.
- Harackiewicz, J. M., & Sansone, C. (1991). Goals and intrinsic motivation: You can get there from here. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement" Goals and self-regulation* (Vol. 7, pp. 21-49). Greenwich, CT: JAI Press.
- Harper, D. (2002). Talking about pictures: A case for photo elicitation. *Visual studies*, *17*(1), 13-26.
- Hartel, J. (2014). An arts-informed study of information using the draw-and-write technique. *Journal of the Association for Information Science and Technology*, *65*(7), 1349-1367.
- Harrison, B. (2002). Photographic visions and narrative inquiry. *Narrative inquiry*, *12*(1), 87-111.
- Hattrup, K., & Jackson, S. E. (1996). Learning about individual differences by taking situations seriously. In K. R. Murphy (Ed.), *Individual differences and behavior in organizations*: 507-547. San Francisco: Jossey Bass.
- Hecht, I. W., Higginson, M. L., Gmelch, W. H., & Tucker, A. (1999). *The Department Chair as Academic Leader. American Council on Education/Oryx Press Series on Higher Education*. Oryx Press, PO Box 33889, Phoenix, AZ 86067-3889.
- Henderson, C., Finkelstein, N. D., & Beach, A. (2010). Beyond dissemination in college science teaching: An introduction to four core change strategies. *Journal of College Science Teaching*, *39*(5), 18–25.
- Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *Journal of Research in Science Teaching*, *48*(8), 952–984. doi: 10.1002/tea.20439
- Hofer, B., Yu, S., & Pintrich, P. R. (1998). Teaching college students to be self-regulated learners. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulated learning: From teaching to self-reflective practice* (pp. 57-85). New York: Guilford.
- Hopmann, S. (1991). "The Multiple Realities of Curriculum Policy Making." *Paper presented at an annual meeting of AERA*, April, Chicago, Illinois.

- Hough, L. M., & Oswald, F. O. (2008). Personality testing and I-O psychology: Asking questions, offering answers, discussing unknowns, and providing direction. *Industrial and Organizational Psychology: Perspectives on Science and Practice*, 1: 272-290.
- Houtz, L. E. (1995). Instructional strategy change and the attitude and achievement of seventh- and eighth-grade science students. *Journal of Research in Science Teaching*, 32(6), 629-648.
- Holyoak, K. J. (1991). Symbolic connectionism: Toward third-generation theories of expertise. In K. A. Ericsson and J. Smith (Eds.), *Toward a general theory of expertise*: 301-336. Cambridge, UK: Cambridge University Press.
- Huebner, D. (1966). Curricular language and classroom meanings. In J. B. MacDonald & R. S. Leeper (Eds.), *Language and meaning*. Washington, DC: Association for Supervision and Curriculum Development.
- Hutcheson, P. A. (1997). Structures and practices. *Handbook of the Undergraduate Curriculum: A Comprehensive Guide to Purposes, Structures, Practices, and Change*, JG Gaff and JL Ratcliff, Eds. San Francisco: Jossey-Bass. 100-117.
- Hutchings, P. (1995). *From idea to prototype: the peer review of teaching: a project workbook*. Washington, DC: AAHE Teaching Initiative, American Association for Higher Education.
- Hutchings, P. (1996). *Making teaching community property: A menu for peer collaboration and peer review*. Washington, DC: AAHE Teaching Initiative, American Association for Higher Education.
- Ilgen, D. R., & Hollenbeck, J. R. 1991. The structure of work: Job design and roles. In M. D. Dunnette & L. M. Hough (Eds.), *Handbook of industrial and organisational psychology* (2nd ed.): 165-207. Palo Alto, CA: Consulting Psychology Press.
- Ivankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using mixed-methods sequential explanatory design: From theory to practice. *Field methods*, 18(1), 3-20.
- Jamieson, L., & Lohmann, J. (2009) *Creating a Culture for Scholarly and Systematic Innovation in Engineering Education*. Washington, D.C: American Society for Engineering Education.
- Jordan, S. & Lande, M. (2015). Additive innovation in design thinking and making. *International Journal of Engineering Education*, 32(3), 1438--1444.
- Karabenick, S., & Sharma, R. (1994). Seeking academic assistance as a strategic learning resource. In P. R. Pintrich, D. R. Brown, & C. E. Weinstein (Eds.), *Student motivation, cognition, and learning: Essays in honor of Wilbert J. McKeachie* (pp. 189-211). Hillsdale, NJ: Erlbaum.

- Kanfer, R., & Ackerman, P. L. 1989. Motivation and cognitive abilities: An integrative/aptitude-treatment interaction approach to skill acquisition. *Journal of Applied Psychology*, 74: 657-690.
- KEEN (n.d.1). In just one year, transform your teaching, research, or service: The faculty development program. KEEN: Engineering Unleashed.
<https://engineeringunleashed.com/Faculty-Development>
- KEEN (n.d.2). Resources: The exemplars of entrepreneurially minded learning: Curriculum. KEEN: Engineering Unleashed. <https://engineeringunleashed.com/resources.aspx>
- Kezar, A. (2012) "The Path to Pedagogical Reform in the Sciences: Engaging Mutual Adaptation and Social Movement Models of Change," *Liberal Education*, 98 (1), pp. 40-45.
- Kozlowski, S. W. J., Gully, S. M., Nason, E. R., & Smith, E. M. (1999). Developing adaptive teams: A theory of compilation and performance across levels and time. In D. R. Ilgen & E. D. Pulakos (Eds.), *The changing nature of work performance: Implications for staffing, personnel actions, and development*. 240-292. San Francisco: Jossey-Bass.
- Kozlowski, S. W. J., Gully, S. M., Salas, E., & Cannon-Bowers, J. A. (1996). Team leadership and development: Theory, principles, and guidelines for training leaders and teams. In M. Beyerlein, D. Johnson, & S. Beyerlein (Eds.), *Advances in interdisciplinary studies of work teams: Team leadership*, vol. 3: 251-289. Greenwich, CT: JAI.
- Kriewall, T. J., & Mekemson, K. (2010). Instilling the entrepreneurial mindset into engineering undergraduates. *The journal of engineering entrepreneurship*, 1(1), 5-19.
- Kuhl, J. (1984). Volitional aspects of achievement motivation and learned helplessness: Toward a comprehensive theory of action control. In B. Maher & W. Maher (Eds.), *Progress in experimental personality research* (Vol. 13, pp. 99-171). New York: Academic Press.
- Kuhl, J. (1985). Volitional mediators of cognition-behavior consistency: Self-regulatory processes and action versus state orientation. In J. Kuhl & J. Beckman (Eds.), *Action control: From cognition to behavior* (pp. 101-128). Berlin: Springer-Verlag.
- Kuhl, J. (2000). "A functional-design approach to motivation and self-regulation," in *Handbook of Self-Regulation*, eds M. Boekaerts, P. R. Pintrich, and M. Zeidner (San Diego, CA: Academic Press), 111-169.
- Lande, M. & Jordan, S. S. (2017). Young Makers Becoming the Engineers of the Future and Implications. *2017 ASEE Annual Conference & Exposition*.
- Lattuca, L. R., & Stark, J. S. (2009). *Shaping the college curriculum: Academic plans in context*. John Wiley & Sons.

- Lattuca, L. R., Terenzini, P. T., & Volkwein, J. F. (2006). *Engineering change: Findings from a study of the impact of EC2000, final report*. Baltimore, MD: Accreditation Board for Engineering and Technology.
- Leaming, D. R. (2007). *Academic leadership: A practical guide to chairing the department*. (2nd ed.) Boston: Anker Publishing.
- Levine, A. (1978). *Handbook on undergraduate curriculum*. Francisco: Jossey-Bass.
- Locke, E. A. (1991). Goal theory vs. control theory: Contrasting approaches to understanding work motivation. *Motivation and Emotion*, 15, 9-28.
- Loughran, J. (1996). *Developing reflective practice: learning about teaching and learning through modelling*. London: Falmer Press.
- Locke, E. A., & Latham, G. P. (1990). *A theory of goal setting and task performance*. Englewood Cliffs, NJ: Prentice-Hall.
- London, J. S., Bekki, J. M., Brunhaver, S. R., Carberry, A. R., & McKenna, A. F. (2018). A Framework for Entrepreneurial Mindsets and Behaviors in Undergraduate Engineering Students: Operationalizing the Kern Family Foundation's "3Cs". *Advances in Engineering Education*, 7(1), n1.
- Lucas, A. F. (1994). *Strengthening departmental leadership: A team-building guide for chairs in colleges and universities*. San Francisco: Jossey-Bass.
- Macey, W. H.; & Schneider, B. (2008). The meaning of employee engagement. *Industrial and Organizational Psychology*, 1: 3-30.
- Mach, E. (1988). *Great contemporary pianists speak for themselves*. Toronto, Canada: Dover Books.
- Maehr, M. L., & Mldgley, C. (1991). Enhancing student motivation: A school-wide approach. *Educational Psychologist*, 26, 399-427.
- Mann, C. (1918). *A Study of Engineering Education*. The Carnegie Foundation for the Advancement of Teaching.
- Marsh, H. W. (1990). A multidimensional, hierarchical model of self-concept: Theoretical and empirical justification. *Educational psychology review*, 2(2), 77-172.
- Martin, M. M. & Rubin, R. B. (1994) Development of a Communication Flexibility Scale. *Southern Communication Journal*, 59, 171-178.

- Matusovich, H.; Paretti, M.; McNair L.; & Hixson, C. (2014) "Faculty motivation: A gateway to transforming engineering education," *Journal of Engineering Education*, vol. 103, no. 2, pp. 302-330.
- Maxwell, J. (2005). *Qualitative research design: An interactive approach* (2nd ed.). Thousand Oaks, CA: Sage Publications
- Mayhew, L. B., & J. Ford. (1971) *Changing the Curriculum*. San Francisco: Jossey-Bass.
- McClelland, D. C. (1998). Identifying competencies with behavioral-event interviews. *Psychological Science*, 9(5), 331–339.
- McCoach, D. B., Gable, R. K., & Madura, J. P. (2013). *Instrument development in the affective domain*. New York, NY: Springer.
- McCombs, B. L. (1989). Self-regulated learning and academic achievement: A phenomenological view. In *Self-regulated learning and academic achievement* (pp. 51-82). Springer, New York, NY.
- Meichenbaum, D. (1977). *Cognitive-behavior modification: An integrative approach*. New York: Plenum.
- Merton, P., Froyd, J. E., Clark, M. C., & Richardson, J. (2009). A case study of relationships between organizational culture and curricular change in engineering education. *Innovative Higher Education*, 34(4), 219-233.
- Mettetal, G. (2001). The what, why and how of classroom action research. *Journal of the Scholarship of Teaching and Learning*, 2(1), 6–13.
- Meyer, R. D., Dalal, R. S., & Bonaccio, S. (2009). A meta-analytic investigation into situational strength as a moderator of the conscientiousness-performance relationship. *Journal of Organizational Behavior*, 30: 1077-1102.
- Meyer, R. D., Dalal, R. S., & Hermida, R. (2010). A review and synthesis of situational strength in the organizational sciences. *Journal of management*, 36(1), 121-140.
- Miller, G., Galanter, E., & Pribram, K. (1960). *Plans and the structure of behavior*. New York: Holt.
- Miller, V. D., Johnson, J. R., & Grau, J. (1994). Antecedents to willingness to participate in a planned organizational change. *Journal of Applied Communication Research*, 22: 59-80.
- Mischel, W. (1973). Toward a cognitive social learning reconceptualization of personality. *Psychological Review*, 80: 252-283.

- Mischel, W. (1977). The interaction of person and situation. In D. Magnusson & N. S. Endler (Eds.), *Personality at the crossroads: Current issues in interactional psychology*. Hillsdale, NJ: Erlbaum.
- Morse, J. M. (1991). Approaches to qualitative-quantitative methodological triangulation. *Nursing research*, 40(2), 120-123.
- Murphy, K. R., & Dziewieczynski, J. L. (2005). Why don't measures of broad dimensions of personality perform better as predictors of job performance? *Human Performance*, 18: 343-357.
- "NAE" (2004). *The Engineer of 2020*. Washington, D.C.: National Academies Press.
- "NAE" (2008). *Changing the conversation: Messages for improving public understanding of engineering*. Committee on public understanding of engineering messages. Washington D.C.: National Academies Press. Retrieved from <http://books.nap.edu/>
- "NRC." National Research Council (NRC). (2012). *Discipline-based educational research: Understanding and improving learning in undergraduate science and engineering*. Washington, DC: National Academies Press.
- Nelson-Le Gall, S. (1981). Help-seeking: An understudied problem solving skill in children. *Developmental Review*, 1, 224-246.
- Nelson-Le Gall, S. (1985). Help-seeking behavior in learning. *Review of research in education* (Vol. 12, pp. 55-90). Washington DC: American Educational Research Association.
- Newman, R. (1991). Goals and self-regulated learning: What motivates children to seek academic help? In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement: Goals and self-regulatory processes* (Vol. 7, pp. 151-183). Greenwich, CT: JAI Press.
- Newman, R. (1994). Adaptive help-seeking: A strategy of self-regulated learning. In D. H. Seunk & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 283-301). Hillsdale, NJ: Erlbaum.
- Nicholis, J. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review*, 91, 328-346.
- Nicholls, J. (1989). *The competitive ethos and democratic education*. Cambridge, MA: Harvard University Press.
- "NSB" (2007). *Moving forward to improve engineering education*. National Science Board. Retrieved from <http://www.nsf.gov/pubs/2007/nsb07122/index.jsp>

- Pace, C. R. (1985). Perspectives and problems in student outcomes research. In P. T. Ewell (Ed.). *Assessing Educational Outcomes* (pp. 7-18). (New directions for institutional research, No. 47). San Francisco: Jossey-Bass.
- Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in Psychology*, 8, Article 422. <https://doi.org/10.3389/fpsyg.2017.00422>
- Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal of educational psychology*, 86(2), 193-203.
- Parker, S. (2000). From passive to proactive motivation: The importance of flexible role orientations and role breadth self-efficacy. *Applied Psychology*, 49(3), 447-469.
- Patton, M. Q. (2014). *Qualitative evaluation and research methods*. SAGE Publications.
- “PCAST.” President’s Council of Advisors on Science and Technology. (2012). Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. Washington, DC.
- Peshkin, A. (1993). The goodness of qualitative research. *Educational researcher*, 22(2), 23-29.
- Peters, L. H., Chassie, M. B., Lindholm, H. R., O’Connor, E. J., & Kline, C. R. (1982). The joint influence of situational constraints and goal setting on performance and affective outcomes. *Journal of Management*, 8: 7-20.
- Pinar, W. F. (1974). *Heightened consciousness, cultural revolution, and curriculum theory*. Berkeley, CA: McCutchan.
- Pink, S. (2001). *Doing visual ethnography*. Sage.
- Pintrich, P. R. (1989). The dynamic interplay of student motivation and cognition in the college classroom. In C. Ames & M. L. Maehr (Eds.), *Advances in motivation and achievement: Motivation-enhancing environments* (Vol. 6, pp. 117-160). Greenwich, CT: JAI Press.
- Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In *Handbook of self regulation* (pp. 451-502). Academic Press.
- Pintrich, P. R., McKeachie, W., & Lin, Y.-G. (1987). Teaching a course in learning to learn. *Teaching of Psychology*, 14, 81-86.
- Pintrich, P. R., & Schrauben, B. (1992). Students' motivational beliefs and their cognitive engagement in classroom tasks. In D. Sehung & J. Meece (Eds.), *Student perceptions in the classroom: Causes and consequences* (pp. 149-183). Hillsdale, NJ: Erlbaum.

- Pintrich, P. R., & Schunk, D. H. (1996). *Motivation in education: Theory, research and applications*. Englewood Cliffs, NJ: Prentice Hall Merrill.
- Ployhart, R. E., & Bliese, P. D. (2006). Individual ADAPTability (I-ADAPT) theory: Conceptualizing the antecedents, consequences, and measurement of individual differences in adaptability. In C. S. Burke, L. Pierce, & E. Salas (Eds.), *Understanding adaptability: A prerequisite for effective performance within complex environments*: 3-39. Amsterdam: Elsevier.
- Posner, G. J. (1985). Curriculum knowledge. In T. Husen, & T. N. Postlethwaite (Eds.), *The international encyclopedia of education* (pp. 1223-1227). New York: Pergamon Press.
- Prince, M., Borrego, M., Henderson, C., Cutler, S., & Froyd, J. (2013). Use of research-based instructional strategies in core chemical engineering courses. *Chemical Engineering Education*, 47(1), 27–37.
- Prince, M., & Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of Engineering Education*, 95(2), 123–138.
- Prosser, J., & Schwartz, D. (1998). Photographs within the sociological research process. *Image-based research: A sourcebook for qualitative researchers*, 115-130.
- Posner, G. J., & Rudnitsky, A. N. (2006). *Course design: A guide to curriculum development for teachers* (7th ed.). Boston, MA: Pearson.
- Posner, G. J., & Strike, K. A. (1976). A categorization scheme for principles of sequencing content. *Review of Educational Research*, 46(4), 665-690.
- Powell, J. P., & Shanker, V. S. (1982). The course planning and monitoring activities of a university teacher. *Higher Education*, 11(3), 289-301.
- Pulakos, E. D., Arad, S., Donovan, M. A., & Plamondon, K. E. (2000). Adaptability in the workplace: Development of a taxonomy of adaptive performance. *Journal of Applied Psychology*, 85: 612-624.
- Pulakos, E. D., Schmitt, N., Dorsey, D. W., Arad, S., Borman, W. C., & Hedge, J. W. (2002). Predicting adaptive performance: Further tests of a model of adaptability. *Human Performance*, 15: 299-323.
- Quinn, R. E. (1988). *Beyond rational management: Mastering the paradoxes and competing demands of high performance*. San Francisco: Jossey-Bass.

- Quinn, R. E., Clair, L. S. S., Faerman, S. R., Thompson, M. P., & McGrath, M. R. (1990). *Becoming a master manager: A competing values approach*. Hoboken, NJ: John Wiley & Sons.
- Ratcliff, J. L. (1997). What is a curriculum and what should it be? In J. G. Gaff & J. L. Ratcliff (Eds.), *Handbook of the undergraduate curriculum: A comprehensive guide to purposes, structures, practices, and change* (pp. 5–29). San Francisco: Jossey-Bass.
- Rayess, N. (2016). Instilling an Entrepreneurial Engineering Mindset through a Freshman Design Course. In *Proceedings of the 2016 ASEE Annual Conference and Exposition*.
- Richards, L. (2005). *Handling qualitative data: A practical guide*. Thousand Oaks, CA: SAGE Publications.
- Robrecht, L. C. (1995). Grounded theory: Evolving methods. *Qualitative health research*, 5(2), 169-177.
- Robson, C. (2011). *Real world research* (3rd ed.). Oxford, England: Blackwell.
- Rokeach, M. (1973). *The nature of human values and value systems*. New York: Free Press.
- Riofrio, J.A., Gettens, R., Santamaria, A.D., Keyser, T.K., Musiak, R.E., & Spotts Jr., H.E. (2015). Innovation to Entrepreneurship in the First Year Engineering Experience. In *ASEE Annual Conference and Exposition*
- Ryan, A., & Pintrich, P. R. (1997). "Should I ask for help?" The role of motivation and attitudes in adolescents' help seeking in math class. *Journal of Educational Psychology*, 89, 329-341.
- Rokeach, M. (1973). *The nature of human values and value systems*. New York: Free Press.
- Rosen, M. A., Bedwell, W. L., Wildman, J. L., Fritzsche, B. A., Salas, E., & Burke, C. S. (2011). Managing adaptive performance in teams: Guiding principles and behavioral markers for measurement. *Human Resource Management Review*, 21: 207-122.
- Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Los Angeles, CA: SAGE.
- Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Los Angeles, CA: SAGE.
- Schon, D. A. (1984). *The reflective practitioner: How professionals think in action* (Vol. 5126). Basic books.
- Schmitz, B., Klug, J., and Schmidt, M. (2011). "Assessing self-regulated learning using diary measures with university students," in *Handbook of Self-regulation of Learning and Performance*, eds B. J. Zimmerman and D. H. Schunk (New York, NY: Routledge), 251–266.

- Schmitz, B., & Perels, F. (2011). Self-monitoring of self-regulation during math homework behaviour using standardized diaries. *Metacognition and Learning, 6*(3), 255-273.
- Schmitz, B. & Wiese, B. S. (2006). New perspectives for the evaluation of training sessions in self-regulated learning: time-series analyses of diary data. *Contemp. Educ. Psychol.* 31, 64–96. doi: 10.1016/j.cedpsych.2005.02.002
- Schneider, W., & Pressley, M. (1997). *Memory development between 2 and 20*. Mahweh, NJ: Erlbaum.
- Schraw, G., Dunkle, M, Bendixen, L, & Roedel, T. (1995). Does a general monitoring skill exist? *Journal of Educational Psychology, 87*, 433-443.
- Schunk, D. H. (1982). Verbal self-regulation as a facilitator of children's achievement and self-efficacy. *Human Learning, 1*, 265-277.
- Schunk, D. H. (1994). Self-regulation of self-efficacy and attributions in academic settings. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 75-99). Hillsdale, NJ: Erlbaum.
- Schuster, J. H., Finkelstein, M. J., & Finkelstein, M. J. (2006). *The American faculty: The restructuring of academic work and careers*. JHU Press.
- Schwab, J. J. (1973). The practical 3: Translation into curriculum. *School Review, 81* (4), 501-522.
- Scott, W. R., & Davis, G. F. (2015). *Organizations and organizing: Rational, natural and open systems perspectives*. Routledge.
- Seely, B. E. (2005). Patterns in the history of engineering education reform: A brief essay. In National Academy of Engineering (Ed.), *Educating the engineer of 2020: Adapting engineering education to the new century* (pp. 114–130). Washington, DC: National Academy Press.
- Seymour, E. (2001). Tracking the processes of change in US undergraduate education in science, mathematics, engineering, and technology. *Science Education, 86*(1), 79–105.
- Shapiro, E. S. (1984). Self-monitoring procedures. In T. H. Ollendich & M. Hersen (Eds.), *Child behavior assessment: Principles and procedures* (pp. 148–165). New York: Pergamon.
- Shoss, M. K.; Witt, L. A.; & Vera, D. (2012). When does adaptive performance lead to higher task performance? *Journal of Organizational Behavior, 33*: 910-924.

- Sonenshein, S. (2010). We're changing—or are we? Untangling the role of progressive, regressive, and stability narratives during strategic change implementation. *Academy of Management Journal*, 53: 477-512.
- Simpson, M., Hynd, C., Nist, S., & Burrell, K. (1997). College academic assistance programs and practices. *Educational Psychology Review*, 9, 39-87.
- Smart, J. C., Feldman, K. A., & Ethington, C. A. (2000). *Academic disciplines: Holland's theory and the study of college students and faculty*. Vanderbilt University Press.
- Smith, D. L. & Hatton, N. (1993). Reflection in teacher education: a study in progress. *Educational Research and Perspectives*, 20, pp. 13-23.
- Snow, R., Corno, L., & Jackson, D. (1996). Individual differences in affective and cognitive functions. In D. Berliner & R. Calfee (Eds.), *Handbook of educational psychology* (pp. 243-310). New York: Macmillan.
- Spencer, L. M., & Spencer, S. M. (1993). *Competence at work: Models for superior performance*. Chichester, UK: Wiley.
- Stanczak, G. (2007). *Visual research methods: Image, society, and representation*. Sage Publications.
- Stark, J. S. (1990). Approaches to assessing educational outcomes. *The Journal of Health Administration Education*, 8(2), 210-226.
- Stark, J. S. (2000). Planning introductory college courses: Content, context and form. *Instructional Science*, 28(5), 413-438.
- Stark, J. S. (2002). Testing a model of program curriculum leadership. *Research in Higher Education*, 43(1), 59-82.
- Stark, J. S., & Briggs, C. L. (1998). Program leadership for college curriculum development: A background paper and guide to future research. In *annual meeting of the Association for the Study of Higher Education, Miami, FL*.
- Stark, J. S., & Lattuca, L. R. (1997). *Shaping the college curriculum: Academic plans in action*. Needham Heights, MA: Allyn & Bacon.
- Stark, J. S., & Lowther, M. A. (1986). *Designing the learning plan: A review of research and theory related to college curricula*. Ann Arbor, MI: University of Michigan, National Center for Research to Improve Postsecondary Teaching and Learning. (ERIC Document Reproduction Service No. ED287439)
- Stark, J. S., & Lowther, M. A. (1988). Perspectives on Course and Program Planning. *New Directions for Institutional Research*, 15(1), 39-52.

- Stark, J. S., Lowther, M. A.; Ryan, M. P.; Bomotti, S. S.; Genthon, M.; Martens, G.; & Haven, C. Lynne (1988). *Reflections on Course Planning. Faculty and Students Consider Influences and Goals. From the Program on Curricular Integration and Student Goals*. Ann Arbor, MI: University of Michigan, National Center for Research to Improve Postsecondary Teaching and Learning.
- Stark, J. S., Lowther, M. A.; Bentley, R. J.; Ryan, M. P.; Martens, G.; Genthon, M. L., & others (1990). *Planning introductory college courses: Influences on faculty*. Ann Arbor, MI: University of Michigan, National Center for Research to Improve Postsecondary Teaching and Learning.
- Stark, J. S., & Thomas, A. (1994). *Assessment and program evaluation*. (ASHE Reader Series). Needham Heights, MA: Simon & Schuster Custom Pub.
- Sternberg, R. (1985). *Beyond IQ: A triarchic theory of intelligence*. New York: Cambridge University Press.
- Stokes, C. K.; Schneider, T. R.; & Lyons, J. B. (2010). Adaptive performance: A criterion problem. *Team Performance Management*, 16: 212-230.
- Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Thousand Oaks, CA: Sage Publications.
- Snyder, M., & Ickes, W. (1985). Personality and social behavior. *Handbook of social psychology*, 2(3), 883-947.
- Tashakkori, A., & Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.
- Thompson, J. D. (2003). *Organizations in action: Social science bases of administrative theory*. Transaction publishers.
- Thorkildsen, T., & Nicholls, J. (1998). Fifth graders' achievement orientations and beliefs: Individual and classroom differences. *Journal of Educational Psychology*, 90, 179-201.
- Thoroughman, K. A., Hruschka, A., & Widder, P. (2014). Engineering virtual studio: KEEN modules to foster entrepreneurial mindset in an integrative, first/second year online course. In *Proceedings of the 2014 ASEE/IEEE Frontiers in Education Conference*.
- Thürer, M., Tomašević, I., Stevenson, M., Qu, T., & Huisingh, D. (2018). A systematic review of the literature on integrating sustainability into engineering curricula. *Journal of Cleaner Production*, 181, 608-617.
- Tiberius, R. G. (1995). From shaping performances to dynamic interaction: The quiet revolution in teaching improvement programs. *Teaching Improvement Practices: Successful Strategies for Higher Education*. Bolton, MA: Anker Publishing Company.

- Toombs, W. (1977–1978). The application of design-based curriculum analysis to general education. *Review of Higher Education*, 1, 18–29.
- Toombs, W., & Tierney, W. G. (1991). *Meeting the Mandate: Renewing the College and Departmental Curriculum*. ASHE-ERIC Higher Education Report No. 6, 1991. ASHE-ERIC Higher Education Reports, Washington, DC: The George Washington University.
- Toombs, W., & Tierney, W. G. (1993). Curriculum definitions and reference points. *Journal of Curriculum and Supervision*, 8 (3), 175–195.
- Tucker, A. (1992). *Chairing the academic department: Leadership among peers*. Phoenix, AZ: Oryx Press.
- Urduan, T. (1997). Achievement goal theory: Past results, future directions. In M. L. Maehr & P. R. Pintrich, (Eds.), *Advances in motivation and achievement* (Vol. 10, pp. 99-141). Greenwich, CT: JAI Press.
- Valiance, E. (1985). Ways of knowing and curricular conceptions: Implications for program planning. In E. Eisner (Ed.), *Learning and teaching the ways of knowing, Eighty fourth Yearbook of the National Society for the Study of Education* (pp. 199-217). Chicago: University of Chicago Press.
- Walther, J., Kellam, N., Sochacka, N., & Radcliffe, D. (2011). Engineering competence? An interpretive investigation of engineering students' professional formation. *Journal of Engineering Education*, 100(4), 703-740.
- Walther, J., Sochacka, N. W., & Kellam, N. N. (2013). Quality in interpretive engineering education research: Reflections on an example study. *Journal of Engineering Education*, 102(4), 626-659.
- Webber, J., Scheuermann, B., McCall, C., & Coleman, M. (1993). Research on self-monitoring as a behaviour management technique in special education classrooms: A descriptive review. *Remedial and Special Education*, 14, 38–56.
- Weiner, B. (1986). *An attributional theory of motivation and emotion*. New York: Springer-Verlag.
- Weinstein, C. E., & Mayer, R. E. (1986). The teaching of learning strategies. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 315-327). New York: Macmillan.
- Weinstein, C. E., Schulte, A. C., & Palmer, D. R. (1987). *LASSI: Learning and study strategies inventory*. Clearwater, FL: H. & H. Publishing.
- Weiss, H. M., & Adler, S. (1984). Personality and organizational behavior. *Research in Organizational Behavior*, 6: 1-50.

- Wiedow, A., & Konradt, U. (2011). Two-dimensional structure of team process improvement: Team reflection and team adaptation. *Small Group Research*, 42: 32-54.
- Wiggins, G. T., & McTighe, J. (2005). *Understanding by design*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Winne, P. H., & Hadwin, A. F. (1997). Studying as self-regulated learning. In D. J. Hacker, J. Dunlosky, & A. Graesser (Eds.), *Metacognition in educational theory and practice* (pp. 277-304). Hillsdale, NJ: Lawrence Erlbaum.
- Withey, M. J., Gellatly, I. R., & Annett, M. (2005). The moderating effect of situational strength on the relationship between personality and provision of effort. *Journal of Applied Social Psychology*, 35: 1587-1608.
- Wolters, C., Yu, S., & Pintrich, P. R. (1996). The relation between goal orientation and students' motivational beliefs and self-regulated learning. *Learning and Individual Differences*, 8, 211-238.
- Wood, E., Woloshyn, V. E., & Willoughby, T. (1995). *Cognitive strategy instruction for middle and high schools*. Cambridge, MA: Brookline Books.
- Wright, G. B. (2011). Student-centered learning in higher education. *International Journal of Teaching and Learning in Higher Education*, 23(1), 92-97.
- Yinger, R. (1979). Routines in teacher planning. *Theory into practice*, 18(3), 163-169.
- Zeichner K. & Liston, D. (1987). Teaching student teachers to reflect, *Harvard Educational Review*, 57, pp. 23-48.
- Zimmerman, B. J. (1986). Development of self-regulated learning: Which are the key subprocesses? *Contemporary Educational Psychology*, 16, 307-313.
- Zimmerman, B. J. (1989). A social cognitive view of self-regulated learning and academic learning. *Journal of Educational Psychology*, 81(3), 329-339.
- Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist*, 25, 3-17.
- Zimmerman, B. J. (1994). Dimensions of academic self-regulation: A conceptual framework for education. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 3-21). Hillsdale, NJ: Erlbaum.
- Zimmerman, B. J. (1995a). Self-efficacy and educational development. In A. Bandura (Ed.), *Self-efficacy in changing societies* (pp. 202-231). New York: Cambridge University Press.

- Zimmerman, B. J. (1995b). Self-regulation involves more than metacognition: A social cognitive perspective. *Educational Psychologist*, 29, 217-221.
- Zimmerman, B. J. (1998a). Academic studying and the development of personal skill: A self-regulatory perspective. *Educational Psychologist*, 33, 73-86.
- Zimmerman, B. J. (1998b). Developing self-fulfilling cycles of academic regulation: An analysis of exemplary instructional models, in D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulated learning: From teaching to self-reflective practice* (pp. 1-19). New York: Guilford.
- Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (Chap. 2) San Diego, CA: Academic Press.
- Zimmerman, R. D. (2008). Understanding the impact of personality traits on individuals' turnover decisions: A metanalytic path model. *Personnel Psychology*, 61: 309-348.
- Zimmerman, B. J., Greenberg, D., & Weinstein, C. E. (1994). Self-regulating academic study time: A strategy approach. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 181-199). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Zimmerman, B. J., & Kitsantas, A. (1997). Developmental phases in self-regulation: Shifting from process to outcome goals. *Journal of Educational Psychology*, 89, 29-36.
- Zimmerman, B. J., & Martinez-Pons, M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal*, 23, 614-628.
- Zimmerman, B. J., & Martinez-Pons, M. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of Educational Psychology*, 80, 284-290.
- Zimmerman, B. J., and Moylan, A. R. (2009). "Self-regulation: where metacognition and motivation intersect," in *Handbook of Metacognition in Education*, eds D. J. Hacker, J. Dunlosky, and A. C. Graesser (New York, NY: Routledge), 299–315.

APPENDIX A

IRB APPROVAL FOR RESEARCH INVOLVING HUMAN SUBJECTS



APPROVAL: MODIFICATION

[Ann McKenna](#)
[IAFSE: Engineering, Ira A. Fulton Schools of](#)
480/727-5619
Ann.McKenna@asu.edu

Dear [Ann McKenna](#):

On 6/25/2021 the ASU IRB reviewed the following protocol:

Type of Review:	Modification / Update
Title:	The contribution of faculty adaptability in enacting curricular change in different engineering education contexts
Investigator:	Ann McKenna
IRB ID:	STUDY00012829
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	None

The IRB approved the modification.

When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Hadi Ali
Hadi Ali
Rod Roscoe

Jennifer Bekki

APPENDIX B

RECRUITMENT EMAIL FOR PARTICIPANTS IN CONTEXT I (EM)—

QUANTITATIVE PHASE

Need your input



Dear Prof. [...],

My name is Hadi and I'm a PhD student in Engineering Education at ASU. I'm inviting you to share your experience integrating the Entrepreneurial Mindset (EM) in your classes.

The survey will not take more than 10 minutes!

I hope you can help me in collecting the data I need for this research to understand faculty adaptability in various contexts.

Take the survey

**Please take
10 minutes
to complete!**



**Please share
your experience
in this research**



APPENDIX C

RECRUITMENT EMAIL FOR PARTICIPANTS IN CONTEXT II (COVID)—

QUANTITATIVE PHASE

Need your input



Dear Prof. [...],

My name is Hadi and I'm a PhD student in Engineering Education at ASU. I'm inviting you to share your experience teaching during the COVID-19 pandemic.

The survey will not take more than 10 minutes!

I hope you can help me in collecting the data I need for this research to understand faculty adaptability in various contexts.

Take the survey

**Please take
10 minutes
to complete!**



**Please share
your experience
in this research**



APPENDIX D

RECRUITMENT EMAIL FOR PARTICIPANTS IN CONTEXT I (EM)—

QUALITATIVE PHASE

Dear Prof. [NAME},

My name is Hadi and I'm a PhD student in Engineering Education at ASU. As part of my dissertation work, and after looking at your profile on the *Engineering Unleashed* KEEN Network website, I'm interested in knowing more about your efforts in integrating the Entrepreneurial Mindset (EM) in your classes.

I'm kindly asking if we can arrange a time to meet for less than an hour (via Zoom) next week to share your experience.

I hope you can help me in collecting the data I need for this research to understand faculty adaptability in various contexts. I believe you provide a unique perspective that I wish I can explore with you.

Will you be interested and available [TIME] ?

Thanks again!

Hadi

APPENDIX E

RECRUITMENT EMAIL FOR PARTICIPANTS IN CONTEXT II (COVID)—

QUALITATIVE PHASE

Dear Prof. [NAME],

My name is Hadi and I'm a PhD student in Engineering Education at ASU. I am contacting you asking to share your teaching experience during the COVID-19 pandemic.

I'm kindly asking if we can arrange a time to meet (via Zoom) next week to inquire about specific adjustments you've made.

I hope you can help me in collecting the data I need for this research to understand faculty adaptability in various contexts. I believe you provide a unique perspective that I wish I can explore with you.

Will you be interested and available anytime [TIME]? If not, please let me know in any case and we can arrange another time.

Thanks again!

Hadi

APPENDIX F

QUANTITATIVE SURVEY INSTRUMENT CONSENT FORM

Context I: Integrating the Entrepreneurial Mindset

STUDY TITLE: The contribution of faculty adaptability in enacting curricular change in different engineering education contexts

ABOUT THE STUDY: You are invited to a research study to understand how the adaptability of faculty contributes to curricular change in engineering education. More specifically, I want to understand how different features of different contexts contribute to faculty adaptability.

YOUR PARTICIPATION: I am inviting your participation, which will involve completing one survey today. The survey asks questions about your experiences delivering courses in an engineering curriculum. You may refuse to answer any question on the survey. This survey should take no longer than 10 minutes to complete. You have the right not to answer any question, and to stop participation at any time.

RISKS AND BENEFITS: Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty; for example, it will not affect, or be part of, your evaluation. You must be 18 or older to participate in the study.

This study will benefit efforts of the community of engineering education working on improving the engineering curricula. Although there is no direct benefit to your participation, you may find the activities in this research study help you reflect on your teaching in various contexts. There are no foreseeable risks or discomforts to your participation.

COLLECTED DATA: The data collected for this study will be survey responses only. Responses will be anonymous. Beyond demographical information about gender, race, ethnicity, engineering program, years of teaching and additional relevant experiences, personally identifiable information will not be collected on the survey. We will request information about courses taught by participants. While no personal, directly identifiable data will be collected, inquiring about the course taught (subject, number and title) as well as the semester taught, some faculty member may fear the risk of having their identity recognized indirectly. However, data analysis and reporting will be made through aggregates of data for statistical analysis. No individual cases will be analyzed or reported for this study. The data will be stored on password protected computers, in separate folders.

Only research staff will have access to data collected in this study. All team members will be trained on IRB. The results of this study may be used in reports, presentations, or publications. Results will only be shared in the aggregate form.

QUESTIONS: If you have any questions concerning the research study, please contact the research team at: Hadi Ali (hwali@asu.edu) or PI Dr. Ann McKenna (Ann.McKenna@asu.edu).

INDEPENDENT CONTACT: If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

INVESTIGATORS:

Dr. Ann McKenna
Principal Investigator
Ann.McKenna@asu.edu
(480) 727-5619

Hadi Ali
PhD Candidate
hwali@asu.edu
(480) 410-0426

Please let me know if you wish to be part of the study.

By clicking to proceed in this online survey, you are agreeing to be part of the study.

Context II: Teaching during the COVID pandemic

STUDY TITLE: The contribution of faculty adaptability in enacting curricular change in different engineering education contexts

ABOUT THE STUDY: You are invited to a research study to understand how the adaptability of faculty contributes to curricular change in engineering education. More specifically, I want to understand how different features of different contexts contribute to faculty adaptability.

YOUR PARTICIPATION: I am inviting your participation, which will involve completing one survey today. The survey asks questions about your experiences delivering courses in an engineering curriculum. You may refuse to answer any question on the survey. This survey should take no longer than 10 minutes to complete. You have the right not to answer any question, and to stop participation at any time.

RISKS AND BENEFITS: Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty; for example, it will not affect, or be part of, your evaluation. You must be 18 or older to participate in the study.

This study will benefit efforts of the community of engineering education working on improving the engineering curricula. Although there is no direct benefit to your participation, you may find the activities in this research study help you reflect on your teaching in various contexts. There are no foreseeable risks or discomforts to your participation.

COLLECTED DATA: The data collected for this study will be survey responses only. Responses will be anonymous. Beyond demographical information about gender, race, ethnicity, engineering program, years of teaching and additional relevant experiences, personally identifiable information will not be collected on the survey. We will request information about courses taught by participants. While no personal, directly identifiable data will be collected, inquiring about the course taught (subject, number and title) as well as the semester taught, some faculty member may fear the risk of having their identity recognized indirectly. However, data analysis and reporting will be made through aggregates of data for statistical analysis. No individual cases will be analyzed or reported for this study. The data will be stored on password protected computers, in separate folders.

Only research staff will have access to data collected in this study. All team members will be trained on IRB. The results of this study may be used in reports, presentations, or publications. Results will only be shared in the aggregate form.

QUESTIONS: If you have any questions concerning the research study, please contact the research team at: Hadi Ali (hwali@asu.edu) or PI Dr. Ann McKenna (Ann.McKenna@asu.edu).

INDEPENDENT CONTACT: If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

INVESTIGATORS:

Dr. Ann McKenna
Principal Investigator
Ann.McKenna@asu.edu
(480) 727-5619

Hadi Ali
PhD Candidate
hwali@asu.edu
(480) 410-0426

Please let me know if you wish to be part of the study.

By clicking to proceed in this online survey, you are agreeing to be part of the study.

APPENDIX G

QUALITATIVE INTERVIEW CONSENT FORM

STUDY TITLE: The contribution of faculty adaptability in enacting curricular change in different engineering education contexts

ABOUT THE STUDY: You are invited to a research study to understand how the adaptability of faculty contributes to curricular change in engineering education. More specifically, I want to understand how different features of different contexts contribute to faculty adaptability.

YOUR PARTICIPATION: I am inviting your participation, which will involve conducting this interview with me today. During the interview I will ask questions about your experiences delivering courses in an engineering curriculum. You may refuse to answer any question during the interview. This interview should take no longer than an hour to complete. You have the right not to answer any question, and to stop participation at any time.

RISKS AND BENEFITS: Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty; for example, it will not affect, or be part of, your evaluation. You must be 18 or older to participate in the study.

This study will benefit efforts of the community of engineering education working on improving the engineering curricula. Although there is no direct benefit to your participation, you may find the activities in this research study help you reflect on your teaching in various contexts. There are no foreseeable risks or discomforts to your participation.

COLLECTED DATA: The data collected in this phase of study will be your response to my interview questions in addition to a description of the artifact you brought with you to illustrate your adaptability as a faculty member.

I would like to record this interview using Zoom. Zoom records an audio and video track of the interview. The interview will not be recorded without your permission. If you would like to participate in an audio only interview, turn off your camera. Please let me know if you do not want the interview to be recorded; you also can change your mind after the interview starts, just let me know.

Please note that only audio recording is required for the purposes of this research. However, if you are comfortable with both audio and video recording (mainly for the purposes of a lively discussion during the interview), then written consent will be required.

Responses will be anonymous. We will request information about courses taught by participants. While no personal, directly identifiable data will be collected, inquiring about the course taught (subject, number and title) as well as the semester taught, some faculty member may fear the risk of having their identity recognized indirectly. However, data

analysis and reporting will be made through assigning pseudonyms which will hide your identity. No individual cases will be analyzed or reported for this study. The data will be stored on password protected computers, in separate folders.

Only research staff will have access to data collected in this study. All team members will be trained on IRB. The results of this study may be used in reports, presentations, or publications. Results will only be shared in the aggregate form.

QUESTIONS: If you have any questions concerning the research study, please contact the research team at: Hadi Ali (hwali@asu.edu) or PI Dr. Ann McKenna (Ann.McKenna@asu.edu).

INDEPENDENT CONTACT: If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

INVESTIGATORS:

Dr. Ann McKenna
Principal Investigator
Ann.McKenna@asu.edu
(480) 727-5619

Hadi Ali
PhD Candidate
hwali@asu.edu
(480) 410-0426

Please let me know if you wish to be part of the study.

By clicking to proceed in this online survey, you are agreeing to be part of the study.

First name: _____

Last name: _____

APPENDIX H
INTERVIEW PROTOCOL

- What did you bring with you? [Tell me more.]
- Did you *plan* for this (activity)? How?
 - What do you consider as things that enabled you to *plan* for this (activity)?
 - [Probe: Enablers related to yourself or to the situation during the semester.]
 - [Probe: Was your (activity) in a fully developed stage when you implemented it, or did you continue to develop it as you rolled it out?]
 - What do you consider as things that prohibited you/were in your way to *plan* for this (activity)?
 - [Probe: Barriers related to yourself or to the situation during the semester.]
 - [Probe: Did you feel ready when you started the implementation, or did you feel you needed more time to prepare?]
 - How would you describe your teaching approach?
- How did this (activity) go?
 - Did you *reflect* on the implementation of this (activity)? How?
 - [Probe: How did you measure the impact of that change? Teaching evaluations? Peers feedback? Students grades?]
 - What do you consider as things that enabled you to *reflect* on this (activity)?
 - [Probe: Enablers related to yourself or to the situation during the semester.]
 - What do you consider as things that prohibited you/were in your way to *reflect* on this (activity)?
 - [Probe: Barriers related to yourself or to the situation during the semester.]
 - Do you consider yourself a progressive/novel teacher? Why or why not?
 - Is there anything you would change if you chose to do this activity again?
- Do you consider the *change* you introduced in your class by this (activity) as *significant*? How? Or why or why not?
 - Did you make any *adjustments* after you reflected on your previous implementation of this activity? How?
 - [Probe: Do you consider the majority of your adjustment efforts to have taken place during the semester or after the semester?]
 - What do you consider as things that enabled you to *adjust* this (activity)?
 - [Probe: Do you feel like your unit or school encourages faculty to make changes? <Pause> Why?]
 - [Probe: Enablers related to yourself or to the situation during the semester.]
 - What do you consider as things that prohibited you/were in your way to *adjust* this (activity)?
 - [Probe: Barriers related to yourself or to the situation during the semester.]
 - [Probe: Before implementing, was there ever a time that you wanted to make a change in your teaching approach, but didn't? <Pause> Tell me about that.]
- Do you consider this activity to be a representation of *your adaptability* for change as a faculty member?
 - How would you describe an adaptable faculty member? Do you consider yourself adaptable?

- Do you think you'd have done this activity if you weren't part of [description of context]? <Pause> Why?
- Do you plan to continue implementing this activity, or other activities inspired by this one, in your classroom, going forward?
 - [Probe: If yes, on what timeline would you like to try them? (e.g., next semester, next year)]
- Is there anything else you'd like to add?

<Give them time to reflect. Could be a great opportunity to capture pre-conceptions.>

- What did you bring with you? [Tell me more.]
- Did you *plan* for this (activity)? How?
 - What do you consider as things that enabled you to *plan* for this (activity)?
 - [Probe: Enablers related to yourself or to the situation during the semester.]
 - [Probe: Was your (activity) in a fully developed stage when you implemented it, or did you continue to develop it as you rolled it out?]
 - What do you consider as things that prohibited you/were in your way to *plan* for this (activity)?
 - [Probe: Barriers related to yourself or to the situation during the semester.]
 - [Probe: Did you feel ready when you started the implementation, or did you feel you needed more time to prepare?]
 - How would you describe your teaching approach?
- How did this (activity) go?
 - Did you *reflect* on the implementation of this (activity)? How?
 - [Probe: How did you measure the impact of that change? Teaching evaluations? Peers feedback? Students grades?]
 - What do you consider as things that enabled you to *reflect* on this (activity)?
 - [Probe: Enablers related to yourself or to the situation during the semester.]
 - What do you consider as things that prohibited you/were in your way to *reflect* on this (activity)?
 - [Probe: Barriers related to yourself or to the situation during the semester.]
 - Do you consider yourself a progressive/novel teacher? Why or why not?
 - Is there anything you would change if you chose to do this activity again?
- Do you consider the *change* you introduced in your class by this (activity) as *significant*? How? Or why or why not?
 - Did you make any *adjustments* after you reflected on your previous implementation of this activity? How?
 - [Probe: Do you consider the majority of your adjustment efforts to have taken place during the semester or after the semester?]
 - What do you consider as things that enabled you to *adjust* this (activity)?
 - [Probe: Do you feel like your unit or school encourages faculty to make changes? <Pause> Why?]
 - [Probe: Enablers related to yourself or to the situation during the semester.]

- What do you consider as things that prohibited you/were in your way to *adjust* this (activity)?
 - [*Probe: Barriers related to yourself or to the situation during the semester.*]
 - [*Probe: Before implementing, was there ever a time that you wanted to make a change in your teaching approach, but didn't? <Pause> Tell me about that.*]
 - Do you consider this activity to be a representation of *your adaptability* for change as a faculty member?
 - How would you describe an adaptable faculty member? Do you consider yourself adaptable?
 - Do you think you'd have done this activity if you weren't part of [description of context]? <Pause> Why?
 - Do you plan to continue implementing this activity, or other activities inspired by this one, in your classroom, going forward?
 - [*Probe: If yes, on what timeline would you like to try them? (e.g., next semester, next year)*]
 - Is there anything else you'd like to add?
- <Give them time to reflect. Could be a great opportunity to capture pre-conceptions.>

APPENDIX I
QUALITATIVE ANALYSIS CODE BOOK

Code	Type	Examples of what falls under the code/type (can be positive or negative; e.g., "willingness to allocate time" or "no willingness to allocate time")	Collapsed categories
Planning	W	Time allocation (willingness to)	Time/effort
		Effort allocation (willingness to)	Time/effort
		Intention formation	Intention
		Achievement motivation	Motivation
		Interaction between individual's attributes and contextual factors	Motivation
		Interest in increasing competence	Motivation
		Interest in attaining positive judgement	Motivation
		Interest in avoiding negative judgement	Motivation
		Interest in developing new skills (mastery goals)	Motivation
		Self-orientation in reference to others (performance goals)	Intention
		Interest in completing a task (task-oriented)	Motivation
Planning	SE	Decision making about the selection, organization, and sequencing of new routines/activities/course materials/etc.	Making decisions
		Changing an existing course/activity	Changing
		Introducing a new course/activity	Changing
		Setting goals	Making decisions
		Actual time spent	Time/effort
		Actual effort spent	Time/effort
		Fine-tuning techniques	Changing
		Routine process for planning	Making decisions
		Systematic process for planning	Making decisions
Planning for modifying course offering	Changing		
Adjusting	W	Willingness to control or regulate behavior	Control behavior/context
		Persistence	Responsibility/Persistence
		Motivation	Control behavior/context
		Distinct from the "willingness to plan" code: An attempt to control anxiety/self-worth	Control behavior/context
		Distinct from the "willingness to plan" code: Anticipation of reward/avoidance of consequences	Opportunities
		Contextual control: Desire to control the context	Control behavior/context
		Seeking help	Social interaction

		Social interaction to seek help	Social interaction
		Negotiating a task	Control behavior/context
		Willingness to bear responsibility	Responsibility/Persistence
		Utilization of the position's autonomy/independence	Control behavior/context
		Response to context: engaging in discourse with others about the situation	Social interaction
		Response to context: critical thinking	Control behavior/context
		Response to context: experimenting in a new project	Opportunities
		Taking advantage of opportunities	Opportunities
Adjusting	SE	Development of curricular change (new course, activity, etc.)	Implementation
		Coordination of curricular change (new course, activity, etc.)	Coordination/support
		Implementation of curricular change (new course, activity, etc.)	Implementation
		Showing support for curricular change (new course, activity, etc.)	Coordination/support
		Evaluation of "EXTERNAL STAKEHOLDERS; i.e., other than self" in curricular change (new course, activity, etc.)	Awareness
		Balancing competing values	Implementation
		Comparing autonomy (i.e., creativity in implementation) with accountability (i.e., consequences to program and students)	Awareness
		Evaluation of "shared" responsibility of change	Coordination/support
		Awareness of sense of ownership in change	Awareness
		Periodic discussion of goals	Coordination/support
		Periodic discussion of values	Coordination/support
Reflecting	W	Observing one's performance	Observing performance/self-monitoring
		Motivation for outcome assessment with respect to set goals	Retrospective evaluation
		Self-monitoring (in-action)	Observing performance/self-monitoring
		Deeper retrospective contemplation of practice (on-action)	Retrospective evaluation
		Heightened level of awareness of "task"	Task-context evaluation
		Heightened level of awareness of "context"	Task-context evaluation

		Willingness to self-observe	Observing performance/self-monitoring
		Willingness to self-experiment	Observing performance/self-monitoring
		Willingness to monitor the context	Task-context evaluation
		Willingness to compare contexts	Task-context evaluation
		Willingness to compare contexts as a result of behavioral change	Task-context evaluation
		Awareness of "physiological pressure" to pursue a particular course of action	Observing performance/self-monitoring
Reflecting	SE	Utilization of reflection strategies	Reflecting strategies
		Collecting data for evaluation	Collecting data
		Seeking different ways for evaluation	Reflecting strategies
		Informal evaluation	Collecting data
		Requesting prompt feedback from students	Collecting data
		Student-centered feedback	Focus on outcome/students
		Seeking feedback in a structured way	Collecting data
		Comparing faculty expectations with students expectations	Focus on outcome/students
		Goal-free, holistic feedback about student experience	Open-mindedness
		Open-mindedness for outcome of evaluations (unintended)	Open-mindedness
		Goal-focused assessments	Focus on outcome/students
		Reflecting on self-performance to guide student progress	Focus on outcome/students
		Reflecting on self-performance to improve course planning	Focus on outcome/students
		Reflecting on self-performance to enable discussions with other faculty	Focus on outcome/students
		Reflecting on self-performance to educate students about various aspects of the course	Focus on outcome/students
		Reflecting on self-performance to show responsibility toward assigned teaching tasks	Focus on outcome/students
		Incorporating findings about effective teaching with classroom assessment	Reflecting strategies
		Finding effective ways to describe course learning outcomes	Focus on outcome/students
		Finding effective ways to measure students change	Open-mindedness

		Consulting faculty peers for reviews	Open-mindedness
		Building capacity for future reflections	Open-mindedness