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“YOU CAN TELL THEY CARE”: A PHENOMENOGRAPHIC STUDY OF  
STUDENT EXPERIENCES WITH EMPATHIC CONCERN EXPRESSED BY  
PROFESSORS IN ENGINEERING

by

Kate Youmans

A dissertation submitted in partial fulfillment  
of the requirements for the degree  
of

DOCTOR OF PHILOSOPHY

in

Engineering Education

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UTAH STATE UNIVERSITY  
Logan, Utah

2020

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## ABSTRACT

“You Can Tell They Care”: A Phenomenographic Study of Student Experiences of  
Empathic Concern Expressed by Professors in Engineering

by

Kate Youmans, Doctor of Philosophy

Utah State University, 2020

Major Professor: Dr. Idalis Villanueva  
Department: Engineering Education

Given the increasing complexity of 21<sup>st</sup> century global challenges, and the need to grow the technical workforce, it is imperative to address issues associated with retention in order to bolster graduation rates of engineering students (Chubin et al., 2005; National Academy of Engineering 2004). To achieve this, we must work to create more inclusive and supportive environments that can improve the academic culture and climate of undergraduate engineering programs (Geisinger & Raman, 2013). Professors can play a critical role in shaping academic culture by building rapport with their students, which has been shown to improve engineering student engagement, retention, and self-efficacy (Chen et al., 2008; Micari & Pazos, 2012, 2016; Vogt, 2008). Researchers and philosophers suggest that incorporating expressions of *empathic concern* as part of professors’ teaching practice can support the development of rapport with students (S. Meyers et al., 2019; Rogers, 1958). *Empathic concern*, which can also be interpreted as enactment of care or concern, refers to the motivational and behavioral components of empathy that are expressed through components of understanding, compassion, and non-

judgement (Baston, 2011; Goleman et al. 2017). Within engineering education, there is a growing body of research that investigates curricular initiatives to develop engineering students' empathy as a skill necessary for engineering design. This dissertation study takes a different approach to explore students' perceptions of how engineering professors currently express empathic concern as part of their teaching practice.

Analysis of semi-structured interviews with 27 undergraduate engineering students (13 women and 14 men, which included 4 first generation, 1 Latinx and 1 student of Asian descent) at a large predominately white, land grant, western university suggests that engineering professors currently demonstrate all components of empathic concern including understanding, compassion, and non-judgement. Seven cycles of iterative phenomenographic analysis identified eight distinct experiences of empathic concern described by students including professors who are committed to helping students succeed and professors who create a safe space for asking questions. These experiences represent three fundamental ways professors express empathic concern towards students including: (1) expressing care for students as individuals; (2) cultivating student learning; (3) acknowledging the challenges of engineering education. By understanding and incorporating these expressions of empathic concern into their teaching practice, engineering professors have the opportunity to improve educational experiences and support the persistence of engineering students.

## PUBLIC ABSTRACT

“You Can Tell They Care”: A Phenomenographic Study of Student Experiences with  
Empathic Concern Expressed by Professors in Engineering

Kate Youmans

In order to address the increasingly complex challenges of the 21<sup>st</sup> century, there is a need to continue to grow the technical workforce by improving graduation rates of engineering students. To accomplish this, the culture of engineering programs must shift from demanding or intimidating to more inclusive and supportive. Professors can play a critical role in creating these cultures by building relationships with students. *Empathic concern* is essential in building relationships that can encourage student growth and development. This form of empathy, sometimes referred to as care or concern, is expressed through actions of understanding, compassion, and non-judgement. While research on empathic concern or care in education is common, there is limited research on the use of empathic concern as a teaching practice in engineering programs.

The purpose of this study is to utilize undergraduate student experiences as a means of exploring how professors in engineering programs currently use empathic concern. Analysis of interviews with 27 engineering students (13 women and 14 men, which included 4 first generation, 1 Latinx and 1 student of Asian descent) at a large western university suggests that professors express all components of empathic concern (understanding, compassion, and non-judgement). In addition, students described eight distinct experiences of empathic concern expressed by engineering professors, including professors who are committed to helping students succeed and professors who create a safe space for asking questions. These experiences can be grouped into three fundamental

ways professors can express empathic concern towards students including: (1) expressing care for students as individuals; (2) cultivating student learning; and (3) acknowledging the challenges of engineering education. By understanding and incorporating these experiences of empathic concern into their teaching practice, engineering professors could improve engineering students' educational experiences and help further students' persistence to graduation.

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Kate Youmans

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## CHAPTER I

### INTRODUCTION

Retention remains a persistent challenge in engineering education, which results in a gap between industry needs and the number of qualified engineering graduates. As graduation rates in engineering continue to hover between 40-60%, it is important to address retention related issues in order to support students' successful completion of engineering programs (National Academy of Engineering, 2004). This is particularly important for undergraduate underrepresented minorities whose four-year graduate rates are even lower, at 20% for Black Americans and 22% for students of Latin American descent (Yoder, 2017). A literature review of issues relating to engineering student retention identified classroom and academic climate as a critical factor of attrition in 27 of the 50 studies evaluated (Geisinger & Raman, 2013). Specifically, these studies point to two distinct issues: inadequate teaching and an individualistic culture in engineering education. The first issue suggests students leave engineering programs due to a lack of guidance, personal encouragement, or attention from professors. The second issue suggests, the individualistic culture of engineering creates a lack of community, leading to a sense of isolation and lack of belonging. Each of these issues has a more substantial impact on underrepresented groups in engineering, including women and minorities (Geisinger & Raman, 2013). Advocates interested in increasing diversity and inclusion in the engineering fields call for addressing the large scale cultural issues that perpetuate the "chilly climate" and "survival of the fittest" nature of engineering, which can lead to academic burnout and emotional exhaustion (Christe, 2013; Jensen & Deemer, 2019). As we seek to improve retention rates of engineering students, we must go beyond

implementing curricular changes and look towards creating more inclusive and supportive cultures in engineering programs.

Shifting the culture in engineering programs to be more supportive is an essential but challenging task. Research suggests that professors can play a critical role in achieving this shift by creating supportive learning environments and fostering student-professor relationships (Christe, 2013). Multiple studies point to the importance of student-professor relationships in supporting students' success in engineering programs. A large quantitative study conducted by Vogt (2008) found that increasing student-faculty interactions (academic integration) and reducing faculty distance improved students' self-regulated learning and critical thinking skills, leading to an increase in self-efficacy, academic confidence, and improved GPA.

Further, a multiple regression analysis completed by Micari and Pazos (2016) showed that a connection with instructors, and a feeling of belonging in the classroom environment, increased students' perceptions of their ability to succeed; that in turn contributes to their retention in an engineering major. This supports Micari and Pazos's (2012) prior research that found students who had a more positive relationship with their professor earned higher grades and were more confident in their ability to succeed in a highly challenging academic course (organic chemistry). As part of a qualitative case study in engineering education, students highlighted the importance of positive relationships with professors who had a caring demeanor and who were concerned about their well-being, learning, and future goals (Hong & Shull, 2010). These qualitative and quantitative research studies suggest that placing a greater emphasis on building rapport

between students and professors can support the creation of positive learning environments and improve retention rates undergraduate engineering students.

However, an extensive literature review conducted by Christe (2013) suggests professors in higher education may not recognize the importance of empathic concern within their teaching practice. This may be especially true within the STEM disciplines where technical skills and training are often prioritized (Arghode et al., 2013). Christe (2013) suggests that if we wish to change the “survival of the fittest” nature of engineering, professors must put a greater emphasis on care and compassion within their teaching practice (p. 25). Vogt (2008) suggests “ongoing educational reforms must encourage engineering professors to understand the significance of their student-professor relationships and seriously undertake measures to become more personally available to students” (p. 27). While many studies draw attention to the importance of student-professor relationships in supporting students in STEM fields, there is limited research that identifies the actions or behaviors professors can use develop these relationships within the context of engineering programs.

One potential strategy for establishing these relationships is the use of *empathic concern* by engineering professors’ as a tool to facilitate understanding and build rapport with engineering students. Within the overarching concept of empathy, this specific form of “empathic concern” refers to “the ability to sense what another person needs from you” (Goleman et al., 2017 p.6). For the purposes of this study we expand on Goleman’s definition and define *empathic concern* as the form of empathy that relates to the motivational and behavioral components of empathy, that are often perceived as outward expressions of compassion and care (Baston, 2011; Goleman et al., 2017; Rogers, 1975).

According to Rogers (1957), this is a core component of establishing helping relationships that can support individuals' growth and development. In the broader field of education, the concepts of empathic concern and care are closely related and are recognized as a crucial teaching practice to support students (S. Meyers et al., 2019). Research by McAllister and Irvine (2002) demonstrates that empathy can be a powerful tool in creating student-centered environments and supporting positive interactions with students of diverse backgrounds. By demonstrating care within a course context, professors are able to build rapport with students leading to improved student outcomes (T. A. Benson et al., 2005; S. A. Meyers, 2009). While these relationships have many benefits for students, they are often overlooked in favor of introducing technical skills within scientific teaching (Arghode et al., 2013; Christe, 2013). This study explores students' perceptions of how empathic concern is currently expressed as part of the teaching practice of engineering professors. Doing so will help to draw attention to the importance of this teaching practice and provide specific examples for further promoting empathic concern in engineering programs.

In juxtaposition to using empathy as a teaching practice within engineering education, there is a growing emphasis on curricular initiatives to develop engineering students' empathy (Tang, 2018). In this context, empathy is emerging as a critical professional skill to support engineering design and is taught as an element of design thinking, socially responsible design, or collaboration (Walther, Miller, et al., 2017). Initiatives to introduce empathy in the engineering curriculum include introduction of service learning and human-centered design projects as well as specific instruction around empathy and ethics (Hess & Fila, 2016). To date, research around empathy in

engineering education has focused on empathy as a professional skill that students should develop to better understand stakeholders' needs as well as ethical implications of design solutions. Beyond the use of empathy for design, practicing engineers recognize empathic concern and care as a leadership and management skill necessary for establishing relationships and effective collaboration (Hess et al., 2016). In contrast, faculty in engineering felt that empathy was an inherent part of engineering practice, as the underlying goal of the discipline is service to society. Therefore, faculty did not explicitly recognize a need for empathy to be integrated into engineering programs (Strobel et al., 2013). These studies reveal a gap between how faculty, students, and practicing engineers view empathy's purpose within the engineering profession and education programs.

While development of this critical skill should not be overlooked, this research takes a different perspective and seeks to understand how students' describe experience empathic concern expressed as part of the teaching practice of engineering professors. This practice can support the development of student-professor relationships that allow professors to better understand their students and create more supportive learning environments. Integration of this practice into engineering programs has the potential to foster rapport between students and professors and promote engineering student retention.

### **1.1. Study Purpose**

This study is premised on the idea that expression of empathic concern as a teaching practice of engineering professors may help to establish student-professor relationships that support positive learning experiences and retention of engineering students (Chen et al., 2008; Christe, 2013; Vogt, 2008). This purpose of this study is to

explore this idea through investigation of students' experiences with the phenomenon of empathic concern expressed by professors in engineering. Using rich qualitative interview data and phenomenographic analysis, the study identifies how engineering professors currently express the components of empathic concern. Further, the qualitatively different ways engineering students describe experiences of empathic concern are explored. Investigating these experiences from a student perspective highlights the expressions of empathic concern that are important to students. The analysis of this data resulted in the development of recommendations that engineering professors can implement in their courses to build rapport with students and create positive learning environments. While the importance of these practices is recognized in the larger context of higher education, this study will bring awareness to its use in engineering and provide specific recommendations to implement this important teaching practice in the context of engineering programs.

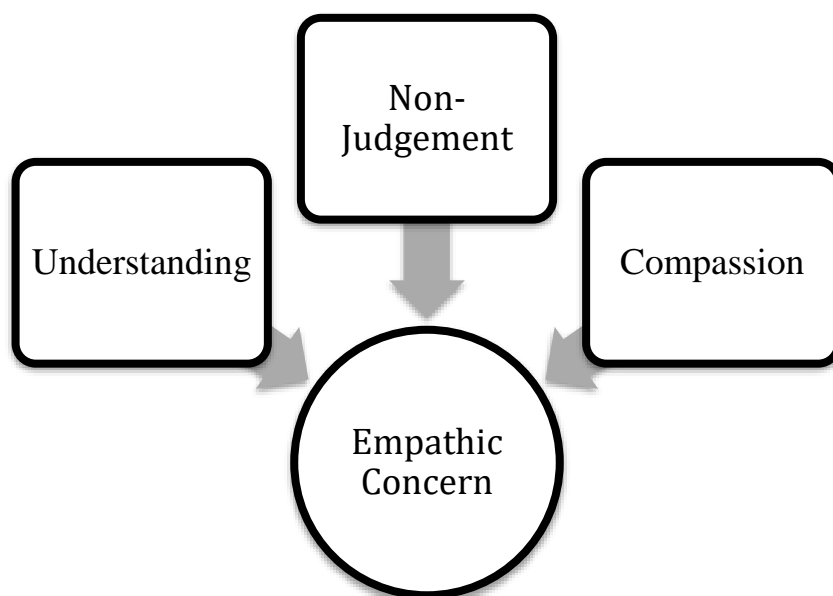
## **1.2. Conceptual Framework**

To clarify the specific construct of empathy explored in this study, a conceptual framework of the components of empathic concern in helping relationships was developed. This framework is based on the description of empathy in helping relationships presented by Rogers (1975) and is further supported by Baston (2011), and Goleman et al. (2017). For the purposes of this study, this specific form of empathy is referred to as *empathic concern*, which relates to the motivational and behavioral components of empathy that are often interpreted as outward expressions of care or concern (Baston, 2011; Rogers, 2017). The conceptual framework, which is illustrated in Figure 1, highlights three key components which support the expression of empathic

concern in helping relationships including, understanding, non-judgement, and compassion.

**Figure 1**

*Components of Empathic Concern in Helping Relationships (Rogers, 1975)*



*Understanding* refers to the component of cognitive and affective empathy that are considered antecedents of empathic concern and allow an individual to understand another's situation or perspective. This component allows an individual to "see the world as others see it" (Baston et al., 2002; Wiseman, 1996). *Non-judgement* supports the unconditional positive regard needed to develop helping relationships by creating a space where an individual can safely share their feelings or needs. (Rogers, 1957; Wiseman, 1996). Finally, *compassion* refers to motivation and behavioral components of empathy that support acts of care or concern (Baston, 2011).

These three components serve as the foundation for the conceptual framework guiding this study. Exploring these components can provide a better understanding of how professors demonstrate empathic concern in their teaching practice. Specifically, this dissertation serves to explore student experiences with the behaviors and actions that professors use to demonstrate understanding, compassion, and non-judgement towards students.

### **1.3. Research Questions**

This exploratory dissertation study seeks to answer the following research questions:

1. How do undergraduate engineering students describe the components of empathic concern (understanding, non-judgement, and compassion) in their experiences with engineering professors?
2. What are the qualitatively different ways undergraduate students describe expressions of empathic concern by engineering professors?

### **1.4. Overview of Research Design**

To explore the phenomenon of empathic concern expressed by professors in engineering, this study utilized a qualitative phenomenographic methodology. Selection of this methodology is appropriate for this exploratory study as it allows for the investigation of multiple realities of the same phenomenon through a constructivist paradigm (Creswell, 2013). Specifically, phenomenography was selected as the methodology to guide this study, as it allows for investigation of the diverse ways individuals perceive or interpret their experiences with a phenomenon (Marton, 1981). As

each students' background and frame of reference may influence their perception of expressions of empathic concern, it is important to explore the different ways students describe their experiences with this phenomenon. Further, phenomenography focuses on understanding the second-order perspective, which allows for the investigation of this phenomenon through students' perspectives at the "receiving" end of a phenomenon rather than the "sending" end of faculty intentions (Cech, 2014).

To support this study, rich qualitative data was collected through semi-structured interviews that asked students to describe their experience with the phenomenon of empathic concern as expressed by engineering professors. Data were collected and analyzed from 27 students currently enrolled as juniors or seniors in engineering or computer science programs at a large western university. This sample population included 14 male students and 13 female students from a variety of disciplines in the College of Engineering and Computer Science. This sample included four first-generation students as well as one student who identified as Latinx and one who identified as Asian and White. Interviews were conducted on campus over a period of six weeks and ranged from 24 to 59 minutes. Following data collection, the interviews were transcribed and de-identified to ensure participant and professor anonymity.

Data analysis was conducted in two phases to address the two research questions in this study. Thematic analysis was utilized in the first phase of data analysis and included summary memo development and descriptive coding to identify the components of empathic concern (understanding, non-judgement, and compassion) present in students' experiences. The second phase of data analysis involved iterative cycles of analysis consistent with the phenomenographic methodology. These cycles of coding

focused on interpretation of collective experiences and involved investigation of the variation between students' experiences. Preliminary categories of description were developed based on the experiences identified in the collective transcriptions. In total, the researcher conducted seven cycles of this iterative analysis to identify the eight final categories of description. These categories of description were then grouped into three overarching themes, and an outcome space that represents students' experiences of professors' expressions of empathic concern was created. The categories of description, themes, and outcome space provide insight into how empathic concern manifests within engineering programs and highlights ways engineering professors could incorporate this teaching practice into courses.

### **1.5. Significance of Study**

This research provides insight into student perceptions of empathic concern expressed by professors in engineering programs and identifies eight distinct experiences of empathic concern described by students. These experiences can be grouped into three overarching themes which describe the fundamental ways that professors can incorporate empathic concern into their teaching practice: (1) expressing care for students as individuals; (2) cultivating student learning; (3) acknowledging the challenges of engineering education. This work is supported by literature in higher education that suggests that building helping-relationships can support learning outcomes and student success (Grantham et al., 2015; S. A. Meyers, 2009; Teven & McCroskey, 1997). In addition, the results of this study expand on the body of literature that suggests the development of student-professor rapport can improve students' self-efficacy and student success in engineering (Micari & Pazos, 2016; Vogt, 2008). By providing specific

examples of actions or behaviors that can build rapport, this research raises awareness of this teaching practice's importance and contextualizes it within engineering programs. By implementing practices aligned with the themes identified as part of this study, engineering professors can make small changes in their respective courses that can create positive learning environments and improve the academic culture in engineering programs.

### **1.6. Assumptions of the Study**

In conducting this study, the researcher assumed that students would be able to describe experiences of empathic concern demonstrated by professors in engineering programs. While the open-ended nature of the interview protocol allowed students to skip or pass on questions they did not wish to answer, the collection of data relied on students describing their experiences of empathic concern. In addition, by selecting a phenomenographic methodology for the study, the assumption was made that individuals experience the phenomenon of empathic concern differently. This assumption allowed for the investigation of multiple interpretations of the phenomenon and helped to identify the variety of ways students identify expression of empathic concern. However, future work may wish to explore the essence of the phenomenon using a phenomenological approach.

### **1.7. Limitations of the Study**

The findings of this dissertation study represent experiences of empathic concern described by 27 students at a Collection of in-depth descriptions of experiences helps to illustrate the variety of ways that students experience empathic concern expressed by

engineering professors. However, due to the small sample size, these experiences may not be generalizable across engineering student populations. This research also focuses on the perspectives of juniors and seniors enrolled in engineering or computer science majors. This focus excludes the perspectives of first and second year students who are likely to be engaged in large lecture courses. Additionally, underrepresented minorities in engineering, including African American and Latinx students are disappointingly, not represented in the sample due to the limited diversity in overall sample population. To truly support these students, it is imperative that further investigations include representations of these populations.

Further, the students who chose to participate in this study did so voluntarily, as no incentives were provided with the study. Students who participated in the study provided a minimum of a half an hour of time to support this research. As such, this sample may represent a subset of students who wished to share their experiences of empathic concern. This subset may leave out students who had non-empathic experiences or could not identify experiences of empathic concern in engineering. In contrast to exploring students' positive experiences with empathic concern, further research is needed to understand students' experiences in engineering programs that lacked empathic concern. Finally, the interpretations of experiences of empathic concern demonstrate students' perceptions of professors' actions. Future work is necessary to explore the motivation and perspectives of empathic concern in engineering education from a professor's viewpoint.

## 1.8. Definitions of Key Terms

*Academic Culture* - Refers to the culture of an academic program, including the underlying values, and beliefs, and attitudes of the students, faculty, and staff involved with those programs (Peterson & Spencer, 1990).

*Affective Empathy* –An individual’s ability to perceive and understand another’s emotional state. Also referred to as emotional empathy which helps one build emotional connections with others (Goleman et al., 2017).

*Attrition* – When a student does not persist in their intended degree program and leaves the program entirely or for another major. Attrition is considered the opposite of retention.

*Categories of Description* – Are used to identify the qualitatively different ways participants describe their experiences with the phenomenon. Each category should be distinct from one another and contribute to capturing the variety of participant experiences (Bowden & Green, 2005; Daly, 2008).

*Chilly Climate* – Describes the unwelcoming or hostile environments which challenge underrepresented individuals’ success in STEM fields (Jensen & Deemer, 2019).

*Classroom Climate* – Refers to the attitudes or behaviors which can contribute to positive or negative environments in a classroom context (Peterson & Spencer, 1990).

*Cognitive Empathy* – An individual’s ability to recognize what another person is thinking or understand another person’s perspective. This form of empathy support communication with others (Goleman et al., 2017)

*Compassion* – The active expression of care or concern for another individual which leads to helping behaviors (Baston et al., 2002).

*Components of Empathic Concern* – Refers to the components of understanding, non-judgment, and compassion which Rogers (1975) describes as being necessary to support expression of empathic concern in helping relationships

*Empathy* – Refers the broad construct of being able to understand and share the thoughts or feelings of another. This includes the three forms of empathy: cognitive empathy, affective empathy, and empathic concern (Goleman et al., 2017).

*Empathic Concern* – The motivational and behavioral components of empathy which can promote pro-social and altruistic behavior. This term is sometimes interpreted as the active expression of care (Baston, 2011).

*Engineering Culture* – Refers to the three ideological pillars of engineering culture identified by Cech (2014) including depoliticization which reduces the focus on public welfare, technical/social dualism which devalues social competency and meritocratic ideologies which suggest social structures are fair and just.

*Engineering Programs* - The undergraduate engineering curriculum and requirements which student engage in in order to complete their engineering degrees. For the purposes of this study Computer Science as well as Engineering majors are included as part of engineering programs.

*Helping Relationship* – Refers to “a relationship in which at least one of the parties has the intent of promoting the growth, development, maturity, improved functioning or

improved coping with life of the other” (Rogers, 1961 p. 40). These relationships can occur in one-on-one settings or individual-group settings such as teaching.

*Key Component* – Refers to the component of empathic concern (understanding, non-judgement, or compassion) which is most prevalent in a particular experience.

*Memo* – Refers to a document used to capture reflexive statements, interpretations and perspectives of the researcher throughout the stages of the research study. These memos are used to help to keep track of the progression of the study and aid in reducing researcher bias in interpretation of the data (Creswell, 2013; Saldaña, 2016).

*Non-Judgement* – Expressing unconditional positive regard for another person. This promote acknowledging and validating another’s experiences or emotions and supports individuals authentically representing their experiences or needs (Rogers, 1958).

*Outcome Space* – A visual representation of the categories of description for a phenomenon which illustrated the relationship between the categories and themes (Daly, 2008).

*Overarching Theme* – Refers to the broad ideas which encompass several categories of description. These themes help to organize the ideas presented in the data and highlight the common ideas which connect categories of description (Creswell, 2013)

*Phenomenology* – A qualitative research methodology used to investigate the common essence in participants experiences with a phenomenon (Larsson & Holmström, 2007).

*Phenomenography* – A qualitative research methodology used to understand a phenomenon through variation in participants experiences with the phenomenon. Exploring the variation in participants experiences provides a deeper understanding of the diverse ways the phenomenon may be perceived (Marton, 1981).

*Phenomenographic Analysis* – The iterative process of data analysis used in phenomenography to explore the variation in participants experiences. This analysis involves cycles of reviewing the collective group of interview transcripts.

*Rapport* – A close or harmonious relationship characterized by understating one another's feelings or ideas which allows for easy communication.

*Retention* – When a student persists and completes from their intended degree program. Retention is often used as a metric to measure or evaluate students' persistence in engineering programs and is considered to be the opposite of attrition.

*Semi-Structured Interview* – A form of data collection that is guided by a pre-determined set of interview questions. This form of data collection allows the researcher flexibility to follow up on ideas or questions brought up by the participant (Creswell et al., 2007).

*Students*- For the purposes of this study, this term refers to the undergraduate students who meet the study inclusion criteria and choose to participate in this study. Their participant was voluntary and was supported by regulatory and ethical approval through the university's institutional review board.

*STEM* – The common acronym standing for Science, Technology, Engineering, and Mathematics.

*Thematic Analysis*- A method of qualitative analysis that explores meanings within the data set and identifies experiences common across multiple interviews. (Saldaña, 2016).

*Understanding* – Is the component of empathic concern that allows an individual to recognize another thoughts or perspectives (Rogers, 1975).

## CHAPTER II

### LITERATURE REVIEW

There is a persistent need to grow the technical workforce that will support the development of innovative solutions to 21<sup>st</sup> century problems (Chubin et al., 2005). However, improving engineering student retention and graduation rates continue to be an enduring challenge in educating the next generation of engineers as four-year graduation rates remain around 33% (Yoder, 2017). Research within engineering education suggests that increased rapport and connection between professors and students can play a critical role in supporting engagement and retention of students in their undergraduate experience (Chen et al., 2008; Micari & Pazos, 2012, 2016; Vogt, 2008). This study explores the integration of empathic concern as a teaching practice of engineering professors which can support the development relationships and increased rapport between professors and students in engineering. While there are several studies that describe how professors express care or empathic concern in higher education (Mariskind, 2014; S. A. Meyers, 2009), there is limited work that contextualizes this practice within engineering programs. This suggest there is an opportunity for professors to incorporating empathy in engineering classrooms by modeling the behavior as part of their teaching practice. As such, we must explore how how this teaching practice is currently used in an engineering education context.

This literature review introduces the reader to the various forms of empathy including cognitive, affective, and motivational types. Empathic concern is defined and the components which support it are discussed. Further, the role of empathic concern in building helping relationships, including teaching, is reviewed. The chapter concludes

with an exploration of how empathy is currently addressed in engineering education, which to date has focused on developing students' empathy as preparation for their professional practice.

## **2.1. Empathy**

Empathy is a complex construct that has its roots in psychology and pertains to an individual's ability to understand and respond to another person's perspective and feelings. The term empathy was coined by Titchener in the early 20th century as a way to refer to the German concept of *Einfühlung* (Wiske, 1986). This concept explores an individual's tendency to project themselves into what they are observing. Originally used to describe aesthetics, the German philosopher Theodor Lipps translated the concept to a psychological context and used it to describe the way in that people come to know one another (Davis, 1996). Since that time, empathy has been explored in cognitive neuroscience (Decety & Ickes, 2011), social psychology (Davis, 1996), as a leadership skill in business (Goleman et al., 2017) and a necessary skill in helping professions such as nursing, social work, and teaching (Kunyk & Olson, 2001; McAllister & Irvine, 2002; S. Meyers et al., 2019; Reynolds & Scott, 1999; Rogers, 1958). The broad application of empathy across multiple disciplines suggests its potential relevance for developing students-professor relationships (S. Meyers et al., 2019). As such, this skill may be appropriate to support the development of rapport between students and professors in engineering programs.

Scholars have debated whether empathy is an inherent trait or a developed skill requiring regulation of one's emotions and cognitive effort. Early research suggested empathy as a trait differing between individuals, while more current views of empathy

suggest that it is both a trait and a skill that can be developed in a professional setting (Morse et al., 1992; Wiseman, 2007). Empathy as a trait is defined as a natural ability to accurately perceive what another person is feeling, while empathy as a skill can be consciously developed as cognitive actions or communication skills (Kunyk & Olson, 2001). Studies by Alligood (1992) and Morse, et al. (1992) suggest that there are two types of empathy: (1) basic empathy that is a developmental trait inherent to humans; and (2) trained empathy (or clinical empathy) that can be developed as a skill within a professional setting. These types of empathy are supported by a large body of research that explores how empathy skills can be developed in nursing students as part of their professional practice (Baillie, 1996; Brink, 1991; Kalisch, 1973; La Monica, 1981; Reynolds & Scott, 1999). Kunyk and Olson (2001) identify six studies in nursing education that identify empathy as a professional state and nine studies that identify empathy as a learned communication skill.

Additionally, research within education shows that empathic concern and helping relationships are an important part of teacher's professional identity and can support the creation of inclusive environments (Cooper, 2011). A survey of K-12 teachers found that 41% of teachers ranked empathy as the most important teacher quality while 62% ranked empathy in the top five qualities of teachers (Cooper, 2004). While there is evidence that empathy may vary in individuals as a trait (Baron-Cohen & Wheelwright, 2004), this group of studies suggest that empathy is a flexible human capacity that can be increased through conscious training of cognitive and behavioral elements (especially communications skills) within a professional setting. For the purposes of this study, empathy is considered a skill that can be improved through conscious development of

cognitive actions and communication skills. The various forms of empathy are presented in the following section.

### 2.1.1 Forms of Empathy: Cognitive, Affective, and Empathic Concern

One of the greatest challenges facing researchers who wish to explore empathy is the multitude of ways that empathy has been conceptualized. In a review of the concept, Cuff et al. (2014) identified forty-three distinct definitions or conceptualizations of the construct of empathy. Baston (2011) describes eight distinct but related concepts of empathy that are presented in Table 1.

**Table 1:**

*Eight Concepts of Empathy (Baston, 2011)*

Concept #	Description	Example
Concept 1	Knowing another person's internal state, including his or her thoughts and feelings	Understanding what a person might be thinking or feeling after losing their job
Concept 2	Adopting the posture or matching the neural responses of an observed other	Mimicking the facial expressions or neural responses of someone who lost their job
Concept 3	Coming to feel as another person feels	Also referred to as affective empathy, understanding the emotions associated with losing a job
Concept 4	Projecting oneself into another's situations	Imagining what it would feel like if you were to lose your job
Concept 5	Imagining how another is thinking or feeling	Imaging how the person is thinking or feeling when they lose their job
Concept 6	Imagining how one would think and feel in the others place	Imagining what you would think or feel if you were to lose your job

Concept #	Description	Example
Concept 7	Feeling distress at witnessing another person's suffering	You feel anxiety or unease learning about the persons' situation
Concept 8	Feeling for another person who is suffering	You feel concern or compassion for the person who is in distress

In an overview of empathy in nursing education, Kunyk and Olson (2001) categorized types of empathy into five groups that define empathy as: (1) human trait; (2) a professional state; (3) a communication process; (4) as the act of caring; and (5) a special relationship, with literature supporting each categorization. With so many different conceptualizations of empathy, it is critical that researchers clarify the intention and meaning behind the construct as it pertains to the context of their study.

Broadly, forms of empathy can be grouped into three types that focus on the cognitive, affective, and motivational forms of the overarching construct (Morse et al., 1992). The cognitive component refers to the ability to understand another persons' perspective, while the affective component refers to the ability to recognize and understand another person's emotion (Goleman et al., 2017; Levenson & Ruef, 1992). The motivational component, which is sometimes referred to as *empathic concern*, is what leads someone to respond compassionately to another person's distress (Baston et al., 1981; Goleman et al., 2017). Zaki (2017) highlights the terms used by researchers to describe these different forms of empathy. These terms are shown in Table 2 and terms describing the form of empathy most relevant to this study (motivational) are highlighted in grey. Each of the three types of empathy (cognitive, affective, and motivational) are related but distinct, and it should be noted that cognitive and affective forms of empathy

used to understand an individual's situation are considered antecedents to empathic concern. This study will focus on the motivational component of empathy, labeled as *empathic concern* that is described in the following section.

**Table 2:**

*Terms used to Describe Forms of Empathy (Adapted from Zaki, 2017)*

<i>Forms of Empathy</i>	Researcher				
	Zaki & Ochsner (2012)	Davis (1994)	Baron-Cohen & Wheelwright (2004)	Baston (2011)	Bloom (2017)
<i>Cognitive</i>	Mentalizing	Perspective Taking	Cognitive Component		
<i>Affective</i>	Experience Sharing	Personal Distress	Affective Component	Personal Distress	Empathy
<i>Motivational (Empathic Concern)</i>	Prosocial	Empathic Concern	Sympathy	Empathy	Compassion

### 2.1.2 Empathic Concern

*Empathic concern* refers to an other-oriented emotion in response to another individual's well-being (Baston, 2011). This type empathy, plays an important role in the motivational and behavioral forms of empathy that prompt individuals to express understanding and act compassionately toward others (Goleman et al., 2017; Rogers, 1957). Goleman (2017) specifically describes *empathic concern* as “the ability to sense what another person needs from you” (p. 6). This form of empathy represents the active expression of empathy in the form of care or concern towards individuals. Empathic

concern is tied to the empathy altruism-hypothesis, which suggests that witnessing another's distress or suffering can serve as altruistic motivation that leads to helping (Baston et al., 2002). A meta-analysis of studies relating to empathy, altruism, and pro-social behavior by Eisenberg and Miller (1987), support this hypothesis and found that empathy is positively correlated with altruistic motivation, which supports compassionate behavior. Rogers (1958), suggest this form of empathy is necessary for establishing helping relationships that can support the success of students in an educational context. Therefore, empathic concern is particularly relevant to establishing rapport between professors and students in engineering. As such this form of empathy is the focus of this research.

## **2.2. Empathic Concern in Helping Relationships**

While Rogers' theory of the conditions necessary for therapeutic personality change (1957) was originally developed in the fields of psychology and psychotherapy, Rogers (1958) suggests that empathic concern is applicable to a broad range of helping relationships that are defined as: "a relationship in that at least one of the parties has the intent of promoting the growth, development, maturity, improved functioning or improved coping with life of the other" (p. 40). These relationships take on a variety of forms including parent-child, therapist-client, or student-teacher relationships.

Rogers (1957) suggests three conditions necessary for establishing these helping relationships, including: (1) genuineness (or congruence); (2) unconditional positive regard; and (3) empathy. Genuineness suggests that to form helping relationships, an individual must be authentically themselves, or that their internal attributes are in congruence with their external actions. Providing unconditional positive regard means

that in forming helping relationships one must not judge the situations, feelings, or actions expressed by the individual they are helping. This is connected to the component of non-judgment in empathic concern. Finally, Rogers suggest, empathy is necessary to understand an individual's experience from within their unique perspective and to act compassionately in response.

This research focuses on the third condition of helping relationships described by Rogers: empathy. As described above, empathy is a complex construct with many different interpretations that explore its cognitive, affective, and motivational forms and is often interpreted as an individual's capacity to understand what another person is experiencing from within that person's frame of reference (Strobel et al., 2013; Wiseman, 2007). Rogers seeks to further clarify his interpretation of empathy in his 1975 publications for *The Counseling Psychologist*. For clarity, this research uses the term *empathic concern* to refer the motivational and behavioral forms of empathy. This form of empathy is further detailed below.

In clarifying his conception of empathic concern, Rogers' highlights three components of empathic concern that can be used to develop helping relationships: understanding, non-judgement, and compassion. First, he describes empathic understanding as the active process of wanting to deeply understand another's unique perspective. Second, he highlights the importance of non-judgement in order to effectively understand this perspective: "to be with another in this way means that for the time being, you lay aside the views and values you hold for yourself in order to enter another's world without prejudice" (Rogers 1975, p. 4). This closely aligns with the concept of unconditional positive regard which Rogers (1957) describes as a condition

necessary for establishing helping relationships. Finally, he emphasizes the need for care or compassion in demonstrating empathic concern: “it is impossible to accurately sense the perceptual world of another person unless you value that person and his world – unless you in some sense care” (Rogers, 1975, p. 7). These components form the foundation for the conceptual framework of empathic concern in helping relationships, which is utilized in this study. This conceptual framework is further illustrated in section 3.4. Exploring the role that empathic concern plays in creating helping relationships, will provide a better understanding of how engineering professors express empathic concern as part of their teaching practice.

### **2.2.1 Empathic Concern in Education**

Empathic concern has long been considered a critical component in developing helping relationships within service professions, such as social work, nursing, and education (Kunyk & Olson, 2001). These relationships can occur in one-on-one settings or individual-group settings, such as teaching (Rogers, 1961). Empathy, and specifically, empathic concern, can be a powerful tool in teaching as it allows educators to deepen their understanding of students and communicate care and concern for students' well-being. S. Meyers et al. (2019) operationalizes empathy within a teaching context as:

The degree to which instructors work to deeply understand students’ personal and social situations, feel caring and concern in response to students’ positive and negative emotions, and communicate their understanding and caring to students through their behavior (p. 2).

This definition aligns with the active behavioral components of empathy, which Baston (2011), describes as empathic concern, as well as the components of empathic concern

necessary for helping relationships, including compassion, understanding, and non-judgement) that Rogers describes (1975).

Research by McAllister and Irvine (2002) found that incorporating empathy can lead to more positive student interactions and create a more student-centered classroom environment. This is particularly important in supporting diverse student populations as empathy and perspective taking allows for the successful implementation of culturally responsive teaching (Warren, 2015). Empathy allows teachers to promote inclusion by “recognizing worth and value in each individual, valuing difference and promoting tolerance” (Cooper, 2011 p. 87). This research suggests empathic concern is central to teaching practice and can be used to better understand students’ diverse backgrounds and create more inclusive environments.

### **2.2.2 Empathy, Sympathy, and Care in Education**

Before continuing to explore empathic concern in teaching, it is important to clarify the relationship between empathy, sympathy, and care. First the difference between empathy and sympathy is discussed. Wispe (1986) defines empathy as “the process whereby one person tries to understand accurately the subjectivity of another person without prejudice” (p. 320), whereas sympathy is “the heightened awareness of the suffering of another person as something to be alleviated.” (p. 318). This distinction is subtle yet important, especially in the context of education. In utilizing sympathy, an individual feels pity or sorrow for the other person and will take actions necessary to mitigate their suffering, even if that means lowering standards for students (S. Meyers et al., 2019; Morse et al., 1992; Wispe, 1986). Whereas, individuals who are practicing empathy focus on understanding, non-judgmentally, an individuals’ context and

providing support without compromising their own standards (S. Meyers et al., 2019). Taking another perspective, sympathy implies the passive act of feeling another's suffering, whereas empathy implies an active attempt to understand another person's experience and reach out through deliberate intellectual effort (Davis, 1996). In this way, empathy, rather than sympathy, is a cognitive process that requires thoughtful effort and can be developed as a professional skill for educators.

Within the context of education, empathy and care are closely related concepts that are both connected to empathic concern and essential in supporting students. Noddings (2012) suggests that caring is necessary within an educational relationship and involves listening, reflecting, and responding, steps that reflect the expression of empathic concern described by Kunyk and Olson (2001). Within engineering, work by Hess et al. (2016) explores how empathy and care are perceived. Responses from practicing engineers suggest that these concepts are closely related. Participants in this study described empathy as the cognitive and affective skills needed to understand another's perspective, while care is the action or behavior of "looking out for the well-being of someone else" (Hess et al., 2016, p. 221). From this perspective, empathy involves passive components, where care refers to the active components of demonstrating understanding and compassion. This view of care aligns with the concept of *empathic concern*, described by Baston (2011) and Goleman et al. (2017), and is an essential condition of the helping relationships necessary in teaching (Rogers, 1958).

There is a body of work that supports the use of care to build relationships in a higher education setting. A review of care in higher education (S. A. Meyers, 2009) found that students prioritized the interpersonal rapport of professors, while in contrast,

professors prioritized their intellectual and instructional role. This study found that the most effective strategies in improving rapport included: “(1) communicating respect, interests and warmth to the student; (2) speaking with the student outside of class; and (3) focusing on the students’ feelings” (p. 206). Professors who implement these or similar strategies developed a greater rapport with students that lead to students becoming more engaged in coursework, improved attendance, and enjoyment of the class (T. A. Benson et al., 2005). In data collected by Grantham et al. (2015) through “Thank a Teacher” submission forms, undergraduate students most frequently thanked faculty for exhibiting empathic concern and care, for their situations. It can be inferred from these research studies that empathic concern is an important aspect of creating supportive student relationships in higher education, which is particularly relevant to student success in engineering. The following section reviews the current applications of empathy in engineering education that, to date, have focused on students developing empathy as a professional skill.

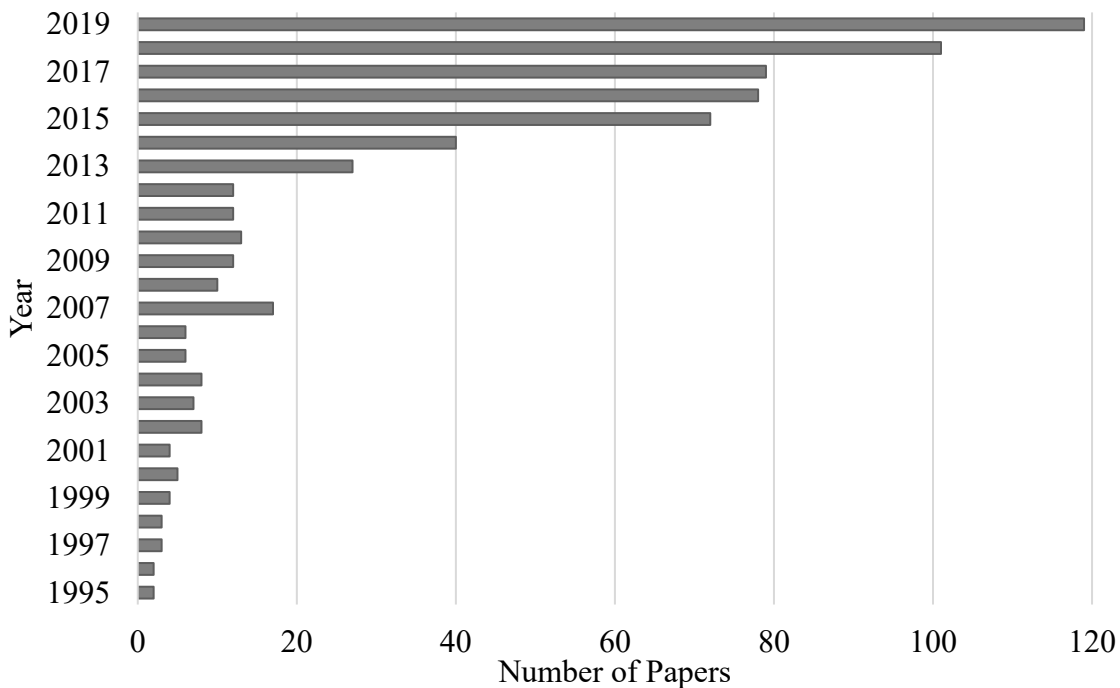
### **2.3. Empathy in Engineering Education**

Empathy is a topic of growing importance in engineering education due to its increasing recognition as a critical skill in engineering professions. A recent genealogy of papers relating to empathy within the American Society for Engineering Education (ASEE) Peer Database is illustrated in Figure 2 and demonstrates that there is a rapidly increasing body of research exploring this topic (Tang, 2018). To date, research on empathy in engineering education has focused on integration of empathy in design, and development of curricular initiatives to foster empathy as a professional skill in students (Tang, 2018; Walther, Miller, et al., 2017). However, there is minimal work that

investigates how professors in engineering build rapport with students by expressing empathic concern as part of their teaching practice. Outside of engineering education, there is a body of work that supports the use of empathic concern, or care, to support students in higher education (Grantham et al., 2015; S. Meyers et al., 2019; S. A. Meyers, 2009). These studies suggest that empathic concern can support student-professors relationships leading to improved retention and academic success. As such, there is an opportunity to investigate this teaching practice through engineering students' personal experiences with their professors using empathic concern in engineering courses.

**Figure 2:**

*Number of Empathy Papers in ASEE Peer Database by Year (Updated from Tang, 2018)*



Early work around empathy in engineering education, between 1996 and 2007, explored empathy as an interpersonal skill, and particularly, as a component of emotional intelligence (Crowley et al., 2001; Riemer, 2003). More rapid growth of empathy as a topic in engineering education occurred after 2007 as human-centered and empathic design became an important focus within the Design in Engineering Education Division (DEED) (Tang, 2018). This focus places an emphasis on engineering students' ability to understand the user's perspective to gain a better understanding of their feelings and needs, so as to more accurately define problem statements and solution spaces (Hess et al., 2017). This is an important skill as the engineering field no longer represents the changing demographics of the US population and must increasingly deal with complex social issues (Chubin et al., 2005; Daily & Eugene, 2013). Currently, underrepresented minorities (URMs), such as Black Americans and students of Latin American origin, make up 4.1% and 11.1% of engineering bachelors, respectively (Yoder, 2017). As such, engineering students must develop empathy in order to understand the diverse perspectives of the communities and individuals who will engage with their proposed design solutions.

As the emphasis on empathy as a professional skill in engineering grows, studies have investigated the current levels of student empathy, as well as empathetic perspectives held by practicing engineers and faculty. Current pedagogical initiatives address ways to foster empathy as a professional skill in students. Finally, a conceptual model of empathy in engineering, intended to help clarify the conception of empathy in an engineering context, is reviewed. Each of these topics is explored in further detail below.

### **2.3.1 Measures of Engineering Student Empathy**

Measures of student levels of empathy have demonstrated that there is a need to engage students in developing their empathy skills. Work by Rasoal et al. (2012) utilized the Interpersonal Reactivity Index developed by Davis (1983) to measure the empathy of students enrolled in physics and computer science as compared to different disciplines including nursing, psychology, medicine, and social work. The results demonstrated that students enrolled in physics and computer engineering had significantly lower empathy than non-engineering students on the empathic concern subscale.

Additionally, work by Jacobs et al. (2019) suggests that the lack of empathy within the engineering fields may be a reason for the low percentage of women. Currently, women make up only 21% of bachelors' degrees pursued in engineering as compared to 50.8% of the general population (United States Department of Commerce, 2018; Yoder, 2017). Utilizing the EQ-SQ scale developed by Baron-Cohen and Wheelwright (2004), the authors found that women in engineering are more empathetic than men, and that students enrolled in science, technology, engineering, and math (STEM) majors are less empathetic than those in non-STEM majors. Further, the study found that students perceived engineering to be less empathetic than other majors, and that lack of empathy influenced their decision to choose a major (e.g., a student with more empathy tends to choose a major outside of STEM fields).

Qualitative work by Fila and Hess found that engineering students recognized empathy as an important component of interpersonal relationships in their everyday life, including the ability to understand others' feelings. However, students struggled to see how empathy is involved in their engineering education, possibly because of the lack of

empathy evident within engineering courses (Fila & Hess, 2016). Additionally, the National Academy of Engineering's report on The Engineer of 2020 (National Academy of Engineering, 2004), and subsequent changes to the Accreditation Board for Engineering and Technology (ABET) criteria, call for an increased emphasis on the development of interpersonal skills and global awareness, in conjunction with the development of technical skills (Lattuca et al., 2006; National Academy of Engineering, 2004).

Taking an alternate perspective, a study by Cech (2014) explored how the culture of engineering may lead to students' disengagement with, or lack of empathy toward, public welfare. The study measured student public welfare beliefs at the beginning and end of their four-year engineering education experience at four universities. This allowed for a comparison between traditional models of engineering education (at Massachusetts Institute of Technology and University of Massachusetts Amherst) and more contemporary models (at Olin College and Smith College), that place a greater emphasis on engineering as a discipline to support public welfare. The results suggest that, as students are further integrated into the culture of engineering programs, their commitment to public welfare declined over the course of their engineering education. Cech (2014) suggests that this trend may be due to three ideological pillars that define the culture of engineering education, including de-politicization, technical/social dualism, and meritocracy. Cech suggest that all three pillars place a greater emphasis on technical concerns and de-value the importance of social consequences. This study suggests there is a need for empathy to be further integrated into the culture of engineering programs as

way to challenge the culture of meritocracy and to draw attention to the importance of social well-fare in addressing 21<sup>st</sup> century challenges.

### **2.3.2 Engineers' Perceptions of Empathy**

It is also important to consider how practicing engineers and engineering faculty describe empathy in order to better understand how empathy fits into the disciplinary culture of engineering. Strobel et al. (2013) completed an extensive literature review of empathy in engineering, disseminated open-ended surveys with practicing engineers, and conducted focus groups with faculty. As part of this study, Strobel et al., 2013 found practicing engineers recognized the importance of empathy in developing relationships, including client and peer relationships. In response to the open-ended survey questions, practicing engineers in particular, recognized the importance of empathy in communication and described it as listening to others, conveying understanding, and showing respect; all behaviors related to demonstrating empathic concern. They also recognized that these behaviors allowed them to successfully build relationships and are particularly important in leadership and management roles.

Work by Hess, Strobel, & Pan (2016) further investigated practicing engineers' conceptualizations of empathy and care and its role in the engineering discipline through semi-structured interviews with 25 practicing engineers (16 males, 9 females). Through thematic analysis of the qualitative data, the researchers identified four categories that practicing engineers identified as important to the practice of engineering. These categories are shown with their associated themes in Figure 3.

**Figure 3:**

*Outcomes of Integrating Empathy into Engineering Practice (Adapted from Hess, Strobel, and Pan, 2018)*

Engineering Outcomes	Intrapersonal Outcomes	Interpersonal Outcomes	Broader Ideas
<ul style="list-style-type: none"> <li>•Meeting the need of multiple users</li> <li>•Delivering high quality solutions</li> <li>•Serving to society</li> </ul>	<ul style="list-style-type: none"> <li>•Understanding others' perspective</li> <li>•Awareness of social impacts</li> <li>•Shifting ones perspective</li> </ul>	<ul style="list-style-type: none"> <li>•Developing meaningful relationships</li> <li>•Improving teamwork</li> <li>•Communicating with others effectively</li> <li>•Developing Management and leadership skills</li> </ul>	<ul style="list-style-type: none"> <li>•Empathy is necessary in engineering</li> <li>•Empathy depends on culture of the company</li> <li>•Empathy is undervalued in engineering</li> </ul>

The category “engineering outcomes” refers to the need for empathy in addressing design problems or designing products. Intrapersonal outcomes refer to the importance of being able to see the world from another’s perspective, such as that of the stakeholder, community, or client. While the interpersonal outcomes of empathy refer to the communication process and action related to empathy (empathic concern) that can be used to develop productive relationships. Finally, the themes in the broader impact category suggest that many engineers recognize the importance of empathy and care within engineering but felt that it was undervalued in engineering practice due to the objective and profit-focused nature of the field. This research suggests that empathy is an important interpersonal skill to practicing engineers. However, studies of engineering students’ perspectives on empathy, described in section 2.3.1, suggest that there is a need to further emphasize empathy as a critical skill and promote it as a part of the culture of engineering programs.

In contrast to professional engineer's views on empathy, faculty in engineering programs may not place as much emphasis on this skill in their courses. In research by Strobel et al., 2013, faculty briefly discussed the role of empathy in supporting students in a course setting, but suggested that, while empathy is valuable, it is not an essential skill in engineering (Strobel et al., 2013). Analysis of the data from the faculty focus groups suggested that faculty view empathy as an intrinsic part of engineering because the field is dedicated to improving society. Consequently, faculty suggested that development of students' empathy is indirectly embedded into their curriculum through teamwork and design courses (Strobel et al., 2013). In this case, it seems that faculty view empathy as innate to the process of engineering design and the engineering profession's service to society, which contrasts with the views of practicing engineering. This view of empathy implies that faculty do not place value on the explicit instruction of empathic skills or modeling of empathic behaviors within a course context. However, work by Noddings (2012) suggests that there is an ethic of care required in educational settings to support students' moral development.

Taken together, the research points to an important disconnect between perceptions of empathy of practicing engineers, engineering faculty, and engineering students. It appears that practicing engineers recognize the value and importance of empathy in engineering (Hess et al., 2016) while faculty believe that empathy is an inherent part of engineering through the innate helping quality of the discipline and thus there is no need to explicitly demonstrate or teach it in their courses (Strobel et al., 2013). These views may lead to a lack of value, modeling of, or explicit instruction around empathy in engineering education programs. These studies suggest that there is an

opportunity for professors to incorporate empathy in engineering classrooms by modeling the behavior as part of their teaching practice.

### **2.3.3 Initiatives to Foster Empathy in Engineering Education**

Since recognizing the importance of empathy as a professional skill to support human-centered design and teamwork, the engineering education community has taken steps to help students develop empathy. Pedagogical initiatives to foster student empathy ranged from: (1) specific instruction in design thinking; (2) engaging students in service learning; (3) modules to build students' communication and collaboration skills; and (4) ethics education (Hess & Fila, 2016). Within the realm of design education, several leaders in the field, such as Stanford's d. School and IDEO (IDEO, 2019; Institute of Design at Stanford, 2016), incorporate empathy as a component of the design-thinking process. This approach has subsequently been integrated into engineering education as part of senior capstone and first-year design courses to help students understand the importance of empathy in the design process (Gray et al., 2015, 2016; Surma-Aho et al., 2018). Work by Hess and Fila (2015) found a significant relationship between perspective taking (a component of empathy) and observation (a component of innovation) which suggests that interventions that teach perspective-taking may help students become more innovative.

Other approaches to incorporating empathy in engineering have focused on developing empathy through service-learning projects. One such project sought to build empathy through a week-long service learning trip to support children who have been effected by HIV/AIDS (Wang et al., 2018), while another program explored ethical and social concerns in connection with the design of drones (Hoople & Choi-Fitzpatrick,

2017). Additional programs partner students with local-non-profit organizations to develop assistive technologies for real customers as a way to develop the skills to better understand a user's perspective (Bell-Huff & Morano, 2017; Schmitt et al., 2016). In an immersive first-year design course, Dodson et al. (2018) incorporated elements of social justice through role playing activities with students. This approach helped students develop appreciation for non-technical challenges in engineering, including issues related to history and social justice. Further, a work study by Hess et al. (2017) introduced modules to develop student empathy within an engineering ethics course. Implementing these modules helped develop students' perspective-taking abilities, including open-mindedness, holistic perspective-taking and a broadening of students' worldviews. These studies demonstrate that undergraduate students benefit from explicit instruction around empathy within an engineering context.

While there are several broad studies that promote the development of interpersonal skills or emotional intelligence (Crowley et al., 2001; Joyner et al., 2012; Riemer, 2001; Vallero & Vesilind, 2006), there is limited research on developing empathy as an interpersonal or communication skill in students. The most prominent work in this area was conducted by Walther et al. (2012) who developed trans-disciplinary course models to cultivate students empathic communication skills. The researchers recognized the importance of clarifying conceptualizations of empathy and demonstrating empathy's relevance to engineering. In order to demonstrate the value of empathy, the instructors also indicated that it was critical to model empathic concern for students within a course setting, and in doing so, provide students with an example of how empathy could impact stakeholders. This wide range of curricular initiatives to

develop students' empathy demonstrates that there are multiple conceptions of the role of empathy within engineering education. Below, a model of empathy, proposed to be contextually relevant to engineering, is reviewed.

#### **2.3.4 Conceptualizing Empathy for Engineering Education**

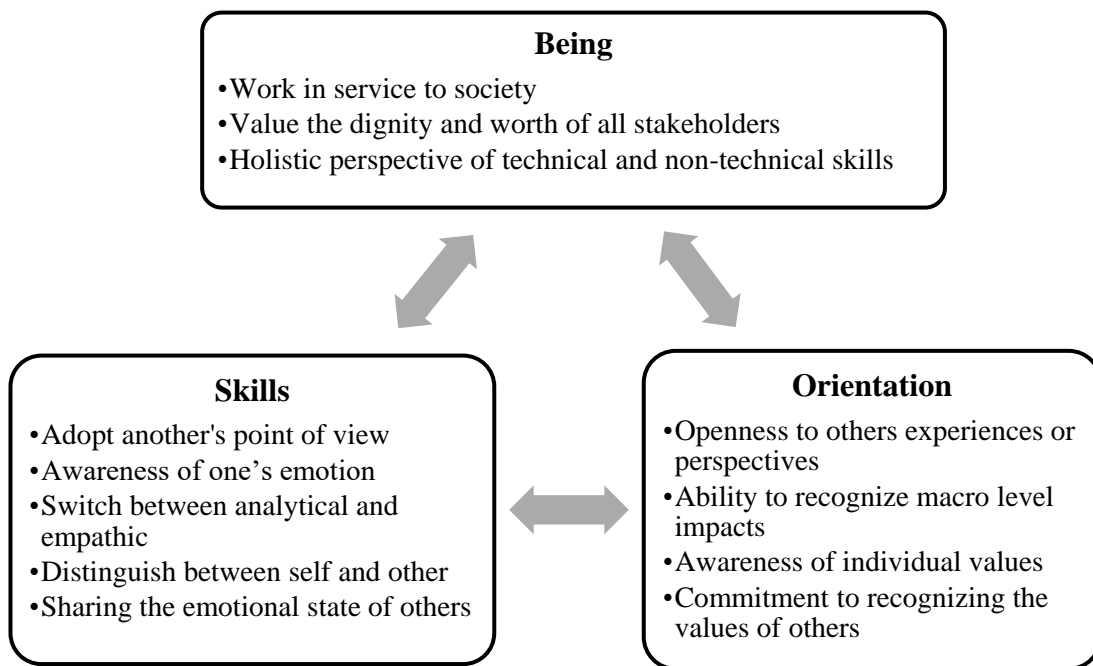
The discrepancy between student, faculty, and practicing engineers' perceptions of empathy, and the varied pedagogical initiatives, demonstrates that conceptions of empathy lack consistency within the engineering field. Much like conceptualizations of empathy in other fields, before effective research and training can be conducted, there must be a synergized model of the phenomenon. As presented in Figure 4, Walther, Miller, et al. (2017) developed a conceptual model of empathy for engineering. This model presents empathy as a core skill, practice orientation, and professional skill within engineering.

Developed through an interdisciplinary collaboration with a social scientist, this model integrates the current understandings of empathy in engineering with models of engineering is social psychology. The model suggests that empathy is a teachable, learnable skill, a practice orientation, and a professional way of being. At the skill level, this model shares elements common among other empathy models, including affective sharing, emotional regulation, perspective taking and awareness of self and others. However, this model adds a skill, contentious "mode switching", that requires engineers to step out of their objective and technical focus and perceive the more subjective components of an engineering problem (p. 134). In identifying empathy as an orientation in engineering, the model highlights the need for engineers to remain open to others' experiences and perspectives. Finally, in identifying empathy as a professional way of

being, the model connects to the nature of the engineering discipline to act in service to society (Walther, Miller, et al., 2017). This model describes the elements of empathy necessary for professional practice in engineering disciplines but does not illustrate how empathy could be incorporated into engineering education programs to improve learning environments and cultural climates.

**Figure 4:**

*Model of Empathy for Engineering (Adapted from Walther, Miller et al., 2017)*



Walther's Model of Empathy for Engineering (2017) emphasizes the integral role that empathy plays in engineers' professional practice. It also creates a foundation to support the development of pedagogical interventions and research on student levels of

empathy. This model aligns with trends in engineering education and continues to focus on developing empathy in students as a professional skill needed to support successful design practices (i.e., understating the stakeholders' perspectives) and understanding of larger social issues (i.e., ethical and social implications of their designs). However, Tang (2018) suggests a need to move beyond the focus of empathy as a practice of engineering excellence and towards a cultural change in engineering education that uses empathy as a basis for fostering understanding and communication. Walther's model for Empathy in Engineering is an appropriate representation of empathy in the professional practice of engineering, which can be used to guide the development of engineering students' empathy. However, it does not address the ways engineering professors can express empathy towards their students to building relationships and rapport. As shown previously (Chen et al., 2008; Vogt, 2008), these factors that have been associated with improving student success and can support persistence (Micari & Pazos, 2012, 2016).

## **2.4. Summary of Literature Review**

This literature review introduces empathy and its various forms, including cognitive, affective, motivational components, specifically identifying empathic concern for its role in building helping relationships (Rogers, 1958, 1961; Zaki, 2017). This form of empathy was selected as the focus for this study as it plays a central role in building relationships (Rogers, 1975). Use of empathic concern and care in engineering programs are reviewed, and studies in the broader field of higher education suggest this is an appropriate tool to support the creation of inclusive environments and understanding of diverse student populations (T. A. Benson et al., 2005; Cooper, 2011; McAllister & Irvine, 2002; S. A. Meyers, 2009). The construct of empathic concern is compared with

definitions of sympathy and care to further clarify its interpretation (S. Meyers et al., 2019; Noddings, 2012). The research suggests empathic concern can be incorporated into teaching practices to create supportive student-professors relationships in higher education and highlights incorporating this teaching practice in engineering programs is particularly relevant to support student success (Christe, 2013; Vogt, 2008).

Further, the body of literature that addresses empathy in engineering education is reviewed to provide an understanding of how this topic is currently addressed in the context of this discipline. Measures of student empathy have overall found that engineering students demonstrate less empathy than their social science counterparts, and a need to foster empathy in engineering education has been proposed (Cech, 2014; Jacobs et al., 2019; Rasool et al., 2012). However, studies of perceptions of empathy of faculty, students and professional engineers, show a discrepancy. Professional engineers recognize empathy as an important component of their professional practice, while faculty descriptions of empathy suggest that it is inherent in the field of engineering and does not need to be explicitly taught or expressed (Strobel et al., 2013). This gap demonstrated an opportunity for faculty to play a larger role in incorporating empathy in engineering classrooms by modeling the behavior as part of their teaching practice. As a first step in addressing this gap, this dissertation seeks to understand student perceptions of empathic concern as expressed by professors in engineering programs in order to provide recommendations for implementation of the teaching practice.

## CHAPTER III

### RESEARCH DESIGN

This study is premised on the idea that integration of empathic concern into engineering professors' teaching practice could support retention by creating and sustaining positive student-professor relationships. Establishing these relationships has the potential to improve students' experiences and promote engineering student retention (Vogt, 2008). To date, research around empathy in engineering education has focused on curricular approaches to support the development of empathy as an approach to design (Tang, 2018; Walther, Miller, et al., 2017). However, there is minimal work that investigates empathic concern as part of the engineering professors' enacted teaching practice. Outside of engineering education, there is a body of work that provides evidence for the use of empathic concern, or care, to support students in higher education (Grantham et al., 2015; S. Meyers et al., 2019; S. A. Meyers, 2009). This suggests there is an opportunity for engineering professors to support students by incorporating empathy as part of their teaching practice. This dissertation explores this opportunity by investigating engineering professors' expressions of empathic concern within their engineering courses, as experienced by their students. By collecting students' experiences of the phenomenon engineering educators can better understand its importance as a teaching practice in engineering.

This study utilized a qualitative phenomenographic approach to explore engineering students' experiences with professors' expression of empathic concern in a course context. Selection of this methodology allows for a greater understanding of the phenomenon through the investigation of differences in students' experiences (Marton,

1981). Using semi-structured interviews, in-depth descriptions of 27 undergraduate engineering students' experiences with empathic concern were collected. Following data collection, thematic analysis was used to explore how the components of empathic concern were represented in students' experiences. Additionally, seven cycles of iterative phenomenographic analysis were conducted to support the creation of categories of description and an outcome space that visually represents distinct experience of empathic concern in engineering programs. Background on this methodology and its use in higher education and engineering are provided in the following sections, along with details of the study design, including research questions, interpretive paradigm, researcher positionality, conceptual framework, sample population, data collection, and analysis procedures.

### **3.1. Research Questions**

In investigating student experiences with empathic concern expressed by professors in engineering programs, this qualitative research was guided by two research questions. The first question investigates the components of empathic concern. Rogers (1975) described these components of understanding, non-judgement, and compassion, as necessary for building helping relationships. Understanding how these components are currently demonstrated provides insight into professors' present use of empathic concern in engineering programs. To understand this phenomenon more deeply, the second research question investigates students' experiences of the qualitatively different ways engineering professors express empathic concern. Awareness of the range of ways professors express empathic concern can provide guidance for the use of empathic

concern as part of their teaching practice. The research questions that guided this qualitative phenomenographic dissertation study are as follows:

1. How do undergraduate engineering students describe the components of empathic concern (understanding, non-judgement, and compassion) in their experiences with engineering professors?
2. What are the qualitatively different ways undergraduate students describe expressions of empathic concern by engineering professors?

### **3.2. Interpretive Paradigm**

Within this dissertation study, the researcher anticipated that students would experience empathic concern from engineering professors differently. Therefore, it was important to explore multiple interpretations of the phenomenon. This research is therefore grounded in a constructivist paradigm, which proposes that reality is subjective to one's own experiences and that there may be multiple views of reality (Creswell, 2013). Using the ontological and epistemological assumptions of the constructivist paradigm allowed for the investigation of multiple realities through a collection of "multiple forms of evidence in themes using the actual words of different individuals" (Creswell, 2013, p. 20). Application of a constructivist paradigm to this research recognizes that there may be multiple interpretations of the phenomenon and allows for an understanding of these diverse experiences through participants' perceptions. In order to understand these multiple views of reality, this study utilized a qualitative phenomenographic methodology, and data collected was explored through an constructivist paradigm. Walther, Sochacka et al. (2017) describes the use of this paradigm in engineering education as a "social inquiry that derives knowledge claims

from the interpretation of lived experiences of individuals or groups” (p. 628). This paradigm “assumes that reality as we know it is constructed intersubjectively through meanings and understandings developed socially and experientially” (Robert Wood Johnson Foundation, 2006, p.1 ). This aligns with the paradigm of interpretivism described by Guba and Lincoln, (1994) that suggests subjective meaning is formed socially and historically through interactions and cultural norms.

Implementing research under this paradigm relies on collecting participants’ views to understand the subjective meanings and multiple realities of an individual’s experience of the phenomenon. The use of qualitative methods within this paradigm allows researchers to gather “experiences, understandings, and perceptions of individuals, for their data to uncover reality, rather than rely on numbers of statistics” (Thanh et al. 2015, p. 24). This interpretive paradigm is particularly relevant within phenomenological and phenomenographic methodologies, which are used to explore a given phenomenon through individuals’ experiences (Chism et al., 2008; Dringenberg et al., 2015). Use of a constructivist paradigm allowed for an understanding of the multiple realities of students’ perceptions of expressions of empathic concern enacted by their engineering professors.

### **3.3. Researcher Positionality**

As part of qualitative research, it is critical that researchers recognize how their own experiences and background influence their interpretation of the results (Creswell, 2013). As an engineering educator, researcher, and specifically a cisgender woman in engineering, I have personally experienced the “chilly climate” of the engineering field both as a professional and in academia. This climate contributed to my leaving the professional engineering field and increased my drive to improve engineering programs

for future generations of engineers and scientists. As an engineering educator with teaching experience in both K-12 and higher education settings, I have experienced firsthand the importance of empathic concern in a course context. This was the greatest lesson I learned as I transitioned from my role as a professional engineer in industry into my role as an educator. As I began to work with diverse student populations, my focus shifted from technical requirements and project timelines to showing compassion and building human connection. Demonstrating empathic concern helped me to become a more effective educator as I was able to build connection and rapport with my students. These experiences drew me to explore how this teaching practice could be applied in a higher education setting, and specifically, in engineering programs.

Within this research, my personal experiences with empathic concern as an educator helped me to explore the characteristics of this phenomenon in students' descriptions of their experiences. However, as a qualitative researcher, I recognize that these perspectives have the potential to influence my own interpretation of student experiences. As such, I have committed to reflexive practices, that involve "integrating knowledge with reflection and acting informed by knowledge, but not constrained by it" (Riley, 2014, p. 6). Reflexivity in this project was supported through reflective memos to create awareness of my interpretations and to ensure students' experiences are authentically portrayed. These memos were created after each interview session and following each iteration of data analysis. Additionally, during each cycle of data analysis, I returned to the collective interview data. Engaging in seven cycles of this analysis helped to ensure that the categories accurately represented experiences represented by

students in the collective interview transcripts. These practices are further detailed in section 3.11.2 which addresses the quality and rigor of the study.

### **3.4. Conceptual Framework**

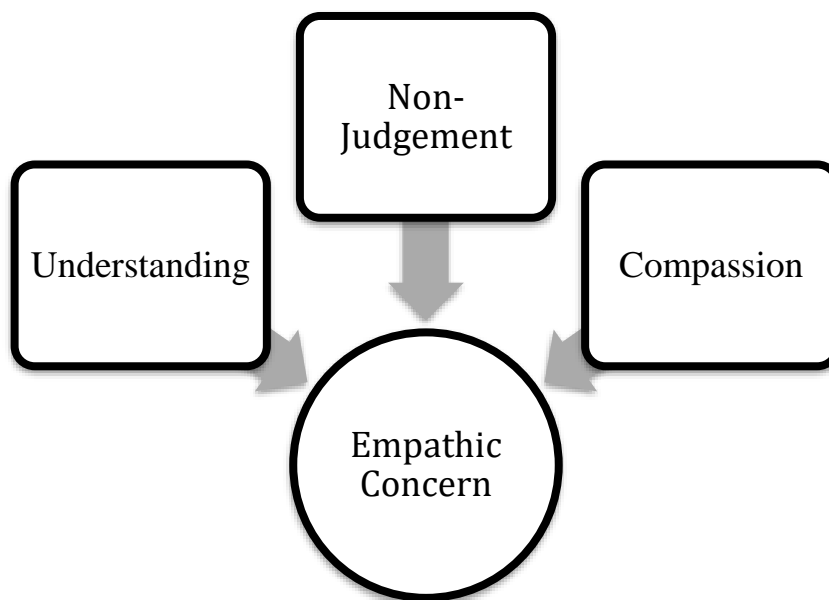
This research is grounded in Carl Rogers' theory of the necessary conditions for therapeutic personality change. This theory is broadly recognized in psychology as contributing to the movement towards person-centered therapy, which helped to shift the focus from the psychologist as expert, to the client as the driver of their individual change (Irving & Dickson, 2006). Rogers (1958, 1961) later expanded this theory into the broader application of helping relationships, including teaching and health care professions. As part of this theory, Rogers (1957) identifies three core conditions necessary for effective helping relationships including: (1) genuineness (or congruence); (2) unconditional positive regard; and (3) empathy. This study specifically focuses on the third condition of empathy and explores its role in the development of helping relationships between professors and student in engineering programs.

To support exploration of this phenomenon, a conceptual framework describing the components of empathic concern necessary for helping relationships was developed. In addition, the conceptual framework, which is presented in Figure 5, helps to clarify the way the complex construct of empathy is defined within the context of this research. For the purposes of this study, the specific form of empathy explored is referred to as *empathic concern*, which relates to the motivational and behavioral components of empathy which are often interpreted as outward expressions of care or concern. This conceptual framework is based on Rogers' 1975 publication which sought to further

clarify empathy in helping relationships. Further the framework is supported by the concepts of empathic concern described by Baston (2011), and Goleman et al. (2017).

**Figure 5:**

*Components of Empathic Concern in Helping Relationships (Rogers, 1975)*



Rogers' (1975) identifies three components needed to demonstrate empathic concern in helping relationships, including understanding, non-judgement, and compassion. *Understanding* refers to the ability to understand an individual's situation and perspective from within that individual's frame of reference (Strobel et al., 2013). This component of empathic concern relies on the cognitive and affective forms of empathy that are considered antecedents of empathic concern. The component of *non-judgement* is necessary to empathic concern as it supports the creation of spaces where individuals feel they can safely share their feelings or needs (Wiseman, 1996). This component is critical to establishing the unconditional positive regard needed to develop

helping relationships (Rogers, 1957). Finally, *compassion* highlights the motivational and behavioral components of empathy, which support the outward expression of care or concern. (Baston, 2011).

These three components serve as the foundation for the conceptual framework that guide this study. Exploring these components provide a better understanding of how professors demonstrate empathic concern in their teaching practice. Specifically, this dissertation served to explore student experiences with the behaviors and actions that professors use to demonstrate understanding, compassion, and non-judgement towards students.

### **3.5. Phenomenographic Methodology**

Within the context of this dissertation study, a qualitative phenomenographic methodology was used to address the research questions described in section 3.1. Walther, Sochacka, et al. (2017) suggest that diverse approaches to qualitative research are necessary to address engineering education's expanding research agenda, including addressing issues of underrepresentation and retention within undergraduate engineering programs. The use of qualitative research methodologies is growing within engineering education as it allows for the investigation of multiple realities, and the examination of participants' lived experiences with a specific phenomenon (Borrego et al., 2009; Creswell, 2013).

A qualitative research approach is appropriate for this study for two reasons. First, because this research topic is relatively new in the field of engineering education (Baier et al., 2020), there is a need for an exploratory study to better understand this phenomenon. Further, a qualitative research methodology is appropriate because it relies

on the collection of rich descriptive data that represents the participants' voices and experiences and presents themes developed through qualitative analysis (Creswell, 2013). By collecting and interpreting this type of data, it is possible to identify how empathic concern manifests within an engineering course setting. Second, use of a phenomenographic methodology allows for the investigation of multiple realities of the same phenomenon through a constructivist paradigm (Chism et al., 2008; Dringenberg et al., 2015). This methodology is particularly applicable as it allows for an investigation of empathic concern through students' lived experiences while accounting for differences within these experiences.

Specifically, a phenomenographic methodology was selected because it allows for the exploration of a phenomenon (in this case, empathic concern expressed by engineering professors) through individuals' (in this case, students') qualitatively different lived experiences. This methodology was developed in Sweden by Ference Marton as a way to understand the "different way in which people experience, interpret, understand, apprehend, perceive or conceptualize various aspects of reality" (Marton, 1981, p. 178). By investigating the variation in students' experiences and perceptions of empathic concern, we can develop specific descriptions of these experiences and an outcome space that can help illustrate how engineering professors currently incorporate empathic concern into their teaching practice. Details of this methodology and its application in engineering and higher education are described in the following sections.

### **3.5.1 Phenomenography vs Phenomenology**

Within qualitative research practice there is some debate around the relationship between phenomenography and phenomenology. Ference Marton (1981) suggests that

these are two distinct methodologies that differ in their use of first order versus second order perspectives and focuses on the essence of an experience versus differences in experiences. In contrast, Cibangu and Hepworth (2016) suggest that phenomenography is a subset of phenomenology as it incorporates many of phenomenology's key ideas, including the need for the researcher to acknowledge their own bias in interpretation of results.

A phenomenological research approach strives to understand the “essence” of the phenomenon by understanding individuals' lived experiences of the phenomenon. This essence is described as the “inner core” of the phenomenon, or the thing, without which, it could not be what it is (Larsson & Holmström, 2007, p. 59). This methodology focuses on investigating the phenomenon to deeply understand the phenomenon's meaning and structure. In turn, this helps clarify what the phenomenon truly means (Larsson & Holmström, 2007). One might argue that the essence of empathy is more closely related to the affective and cognitive forms of empathy that professors experience when they express empathic concern. Therefore, this approach may be more applicable in future research to investigate faculty's experiences of the phenomenon.

In contrast, phenomenography focuses on understanding “how people perceive, experience, and conceptualize” a phenomenon (Marton, 1981, p. 181). This shifts the focus of the research onto individuals' experience of the phenomenon and allows for the investigation of variances in these experiences to better understand the phenomenon (Larsson & Holmström, 2007). The outcome of this approach introduces categories of description that represent the qualitatively different ways that individuals experience the phenomenon. These descriptive categories are developed out of the collective experience

of the group as a whole (Åkerlind, 2012). An outcome space is often developed that describes how these categories are related in a hierarchical organization (Alsop & Tompsett, 2006). Two important attributes of phenomenography including the use of second-order perspectives and a focus on differences in experiences are discussed in the following sections.

### **3.5.2 Second-Order Perspective**

The intent of this study is to understand how students perceive expressions of empathic concern used by engineering professors as part of their teaching practice. Therefore, it is essential to examine experiences of empathic concern through a students' perspective rather than faculties' intended use of empathy. The phenomenographic approach focuses on the second-order perspective that investigates peoples' *experiences* of the world, rather than exploring the world itself as in the first-order perspective (Richardson, 1999). This is an important distinction between intention of professors' actions and the perception, or students' interpretation, of these actions. Exploring this phenomenon from a students' perspective is critical as they are the recipients of these actions, and there may be a disconnect between 'intentions of how empathic concern is expressed and how students experience it (Cech, 2014). This emphasizes the importance of this approach and recommends investigating student experiences on the "receiving" end of a phenomenon rather than the "sending" end of faculty intentions. As such, this study applies the second-order perspective of phenomenography to explore students' experiences of empathic concern expressed by faculty in a course context, with the intention that these experiences may inform future use of empathic concern in engineering faculties' instructional practices.

### 3.5.3 Difference in Experiences

Central to phenomenography is the investigation of differences in experiences to more fully understand the phenomenon. Åkerlind (2018) presents Variation Theory as an extension of phenomenographic research, suggesting that these two approaches are closely related, and it is only by understanding variations that we can come to a deeper appreciation of an experience. Åkerlind (2018) provides the following example:

If everything in the world were the same color, for example green, then the phenomenon of color could not be experienced. Not even a sense of “green” could be experienced as color can only be experienced in contrast to another. Thus, without variation in color, neither the existence of “green” nor the larger phenomenon of color would form part of our awareness or consciousness of the world. Color might exist in the world as such, but it would not exist in people’s experience of the world, that is, we would not be aware of its existence (p. 950).

This study assumes that each students’ background and experiences will influence their perceived experiences of empathic concern. As there may be qualitative differences between each students’ perception of the same phenomenon, this study benefits from the investigation of these differences to more fully understand how empathic concern is expressed by engineering professors. A critical difference between phenomenography and phenomenology is the assumption that individuals experience a phenomenon differently (Richardson, 1999). As such, application of a phenomenographic methodology was appropriate for this study.

Since its introduction, phenomenography has been adapted and implemented as a research methodology in higher education to understand student learning experiences and

their different interpretations (Åkerlind, 2005; Entwistle, 1997; Tight, 2016). More recently, phenomenography has been recognized as an emerging methodology in engineering education (Case & Light, 2011). Research using a phenomenographic approach in each of these fields is discussed below.

### **3.5.4 Phenomenography in Higher Education**

Early phenomenographic studies in higher education explore how university students approached their studies and how these approaches related to their understanding and retention of content material (Marton & Booth, 1997). Investigating these approaches helped researchers understand how students arrived at a deep understanding of a concept, and in turn, allowed for the development of teaching practices to support this type of learning (Booth, 1997). Trigwell and Prosser (2006) use a phenomenographic approach to investigate first year chemistry and physics lecturers' teaching and learning conceptions. Analysis of 24 participants' transcripts revealed a hierarchy in approaches to teaching, conceptions of learning, and conceptions of teaching. At the lowest level, learning happens through transmission of information from instructor to student. At the highest level, learning is aimed at changing students' conceptions, and the teacher serves as a guide to this change. This research, along with Marton and Booth's (1997) investigations of approaches to learning, suggest a need to move from teacher-centered to student-centered learning environments in order to engage students in deeper learning (Åkerlind, 2008). These early applications of phenomenography in higher education suggest that this methodology may be used to investigate students' perception of learning environments including student experiences with professors' teaching practices, such as empathic concern.

More recently, this methodology has been proposed as an effective way to manage differences between researchers and participants in cross-cultural research (Willis, 2018). Phenomenography has also been used to explore the implementation of competence-based education in higher education (Koenen et al., 2015). A recent study of K-12 science education suggests that “the phenomenographic method is illuminating, because the content rich-phenomenographic data can be used to evaluate students’ initial understanding and the evolvement of that understanding of scientific concepts” (Han & Ellis, 2019, p. 1). Prior application of this methodology in an educational setting suggests it is appropriate to explore students’ experiences of empathic concern.

### **3.5.5 Phenomenography in Engineering Education**

Within engineering education, this methodology has been used to explore educational outcomes and pedagogical strategies relating to computer science (Booth, 2001; Bucks et al., 2011; Stamouli & Huggard, 2007), and the transition from pre-college to first year engineering programs (Salzman et al., 2017). Additionally, Hess et al. (2016) utilized a phenomenographic approach in their study of practicing engineers’ perceptions of empathy in engineering. Work by Alsop & Tompsett (2006) details the process of using “pure” phenomenography to understand student learning in information and communication technology education. Through this study, the researchers describe data collection, development of categories of description, and creation of outcome spaces detailing a hierarchical relationship between the categories identified. Notably, in engineering education, dissertation work by Daly (2008) explored conceptualization of the design process across multiple disciplines. This work details the iterative process of phenomenographic analysis that was used to develop categories of description and

address the reliability and quality in the methodology. Each of these studies serves as a model for the application of phenomenography in engineering education research and warrants its continued use in this field.

### 3.5.6 Phenomenographic Considerations

As the phenomenographic methodology becomes more popular in engineering education research, it is important to consider adaptations and strategies within the methodology. The transparency of this process is essential in supporting this type of research (Åkerlind et al., 2005). Work by Dringenberg et al. (2015) provides important insight into using phenomenography in engineering education and provides five key considerations for researchers wishing to implement this methodology. These considerations are summarized below in Table 3, along with the approaches relevant to this study.

**Table 3:**

*Key Considerations for Phenomenographic Research in Engineering Education  
(Dringenberg et al., 2015)*

Consideration	Description	Application in Current Study
Nature of the Phenomenon	How the researcher accurately introduced the phenomenon to a participant without biasing their responses	Empathy is a complex construct that has many interpretations. For the purposes of this study we focus on <i>empathic concern</i> and introduce a working definition of this phenomenon and its components as part of the reflective prompt and interview protocol.

Consideration	Description	Application in Current Study
Stance Toward Participants	How the researcher interacted with participants including: (1) the importance of open communication and empathy in the interview process; (2) bracketing of the researcher's perspectives; and (3) accurate representation of participant experiences	<p>To create a comfortable interview environment, participants were able to select an interview location and time convenient to them. The purpose of the study was shared at the start of the interview, and efforts were made to create a safe and confidential space for participants to share their experiences.</p> <p>To prevent leading within the interview, the researcher developed an interview protocol with primary and follow-up questions that was utilized for all interviews.</p> <p>To ensure accurate representation of a participant's experiences, the researcher engaged seven iterations of data analysis process and collaborated with another researcher for feedback.</p>
Treatment of Data	Researcher must decide if data will be reviewed holistically as an entire transcript or be parsed into quotes representing "pools of meaning"	As is suggested by Åkerlind (2005), the researcher reviewed the interviews holistically to create initial categories. After each cycle of analysis, the researcher returned to the collective set of interviews. After the final categories were created, quotations from the remaining interview were grouped into "pools of meaning" (p. 326).
Development of Outcome Space	The process of iteration and reinterpretation, which the researcher used to create categories based on evidence from the transcripts	<p>In the process of data analysis, the researcher reviewed each transcript eight times.</p> <p>Following each of these readings, the researcher created a memo that summarizes the categories identified within the transcript. The researcher began to develop the outcome space following the sixth iteration of review. After creating a draft outcome space, the researcher reviewed memos and quotes within "pools of meaning" to ensure that evidence in the transcripts is accurately represented (Åkerlind 2005, p. 326).</p>
Application of Outcome Space	The researcher considered how the outcome space developed will be relevant and useful to the field	The outcome space will be developed to represent the categories of empathic concern and relationships between them. This will illustrate student experiences of empathic concern in engineering education.

### 3.6. Sample Population

This study was conducted within the context of the College of Engineering and College of Science at a predominantly white, land grant, western university. With over 2,500 undergraduate engineering students, the university offers undergraduate degrees in Biological Engineering, Civil Engineering, Environmental Engineering, Electrical Engineering, and Mechanical Engineering. In addition, students enrolled in Computer Science majors, which were affiliated with this college until 2019, were invited to participate.

Coursework in these programs follows a traditional engineering or computer science curriculum. This includes students taking general courses such as physics or calculus in their first year. These courses are often taught by faculty outside of the engineering department, for example math or science professors.

During sophomore year, students start to engage in engineering specific courses, such as thermodynamics and statics. Within the context of this engineering program in this study, several of these courses are taught by faculty with backgrounds in engineering education. These sophomore level courses are often conducted in a large (more than 100 students) lecture format with additional smaller sections of recitation sessions taught by a teaching assistant. With enrollments often over 100 students, these courses may be challenging for both students and professors to manage. Students must meet the specific GPA and course requirements of their discipline to move into advanced courses and progress toward degree completion.

These large introductory courses are followed by more discipline-specific courses in students' junior and senior years as part of their professional preparation. These

courses are more advanced and specific to a student's discipline or degree. As such, the courses are smaller, and students have more of an opportunity to engage with engineering professors. For this reason, this study focused on juniors and seniors within the College of Engineering or Computer Science majors who have completed 60 or more credits of coursework towards their undergraduate degrees. This helps ensure that students have advanced on to discipline-specific courses and therefore have experienced at least one course taught by an engineering or computer science professor. Additionally, this would allow students to reflect on their prior experiences in large lecture-based courses and derive from multiple experiences with their instructors, enough to help them self-identify the difference between an empathetic instructor and one who is not. Inclusion criteria for this study was as follows:

1. Participants were enrolled in the Computer Science Department in the College of Science or in an engineering department within the College of Engineering
2. Participants had completed 60 credits of coursework towards completion of their undergraduate degree
3. Participants were 18 years of age or older

### **3.6.1 Recruitment**

One of the goals of the phenomenographic methodology is to explore the difference in how an individual experiences a phenomenon, as such a diverse population sample is recommended (Åkerlind et al., 2005). This goal guided the recruitment strategies, which allowed for purposeful sampling across disciplines and genders. The first recruitment strategy focused on partnering with student organizations such as Society of Women Engineers (SWE), Society of Hispanic Professional Engineers

(SHPE), and Engineers Without Borders (EWB) to recruit student who are traditionally underrepresented in engineering. It should be noted that the school's chapter of National Society of Black Engineers (NSBE) was contacted but is currently inactive on this campus. Placing an emphasis on recruitment of underrepresented students in engineering is necessary to amplify their voices and understand their experiences (Borrego et al., 2009).

To recruit students in these organizations, the researcher partnered with the academic advising office in the College of Engineering of this university to connect with student leadership in each organization. Based on these connections, the researcher attended one student group meetings for EWB and SWE to share information about the study and recruit participants. At each meeting, information on the study was distributed along with a link for students to review the letter of informed consent. A signup sheet was also distributed for any students to provide contact information if they were interested in further participating in the study. Collaborating with these student organizations helped to ensure representation of women in the sample population. However, the researcher had limited success recruiting underrepresented minority students as they are often already overtaxed with request for volunteer participation in outreach, research, and service events at this university.

Additionally, to reach the sample size of 20 or more students, the researcher partnered with engineering education faculty to recruit students from a required junior level course. For this phase of recruiting the researcher visited seven sections of a required communications course. During these visits, a brief description of the research project was presented, and students were invited to provide their contact information if

they wished to receive further information. Additional information including a flyer, letter of informed consent and link to the scheduling page were also provided to interested students.

Finally, all juniors and seniors in the College of Engineering received digital recruitment e-mails through the engineering advising office, which provides tutoring, advising, and mentoring for engineering students. Recruitment materials, including e-mails and flyers, were approved by IRB and are included in Appendix A.

### **3.6.2 Participants**

In total, 28 undergraduate students enrolled as juniors or seniors in the College of Engineering or a Computer Science major, elected to participate in this study. After an interview bias assessment, which is further discussed in section 3.10, one interview was removed from the data set due to the identification of bias during the interview and the number of students who participated in the study was reduced to 27. This sample of students includes 13 women and 14 men, of whom 4 identified as first generation, 1 identified as Latinx and 1 identifies as Asian and White.

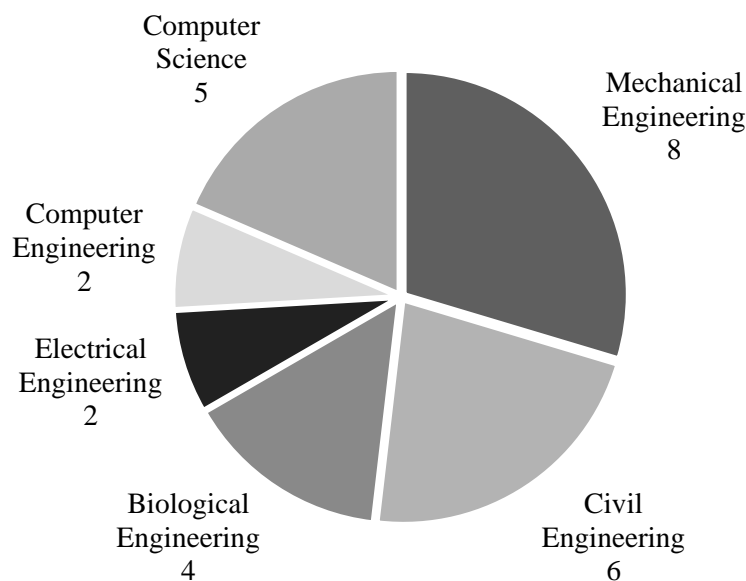
Given that the nature of this work is qualitative, a sample size of 12 or more is enough to ensure a rich experience is collected (Creswell, 2013). However, for the purposes of phenomenographic research, Larsson and Holmström (2007), recommend that 20 participants are needed to identify differences in experiences. A phenomenographic study of design experiences in engineering also supports this sample size (S. Daly, 2009). By collecting a larger sample of data (more than 20 interviews), it is possible to identify variations in experiences of the phenomenon, thus collection of in-

depth interviews with 27 students is adequate to support phenomenographic analysis of student experiences of their professors' expressions of empathic concern.

Student who participated in the study represent all the disciplines within the college, including Mechanical Engineering (8), Civil Engineering (6), Biological Engineering (4), Electrical Engineering (2), Computer Engineering (2) and Computer Science (5) and has an almost equal number of male (14) and female students (13). The percentage of students in each of the disciplines is represented in Figure 6.

**Figure 6:**

*Percentage of Students Representing Each Discipline*



Oversampling underrepresented populations (including females) in engineering was intentional as it can more accurately represent their experiences (Bucks et al., 2011). However, this sample lacked further dimensions of diversity as only four students

identified as first-generation, and only two students identified as non-white, one of whom is an international student. This sample reflects the limited diversity of students enrolled in the College of Engineering and College of Science at this university. The demographics of students enrolled across all majors in the College of Engineering in 2018 included 15 % female students, 0.4% Black or African American students, 4% Hispanic students and 1.8 % Asian students (Office of Analysis, Assessment and Accreditation, 2020). This limitation is discussed further in section 5.3

Table 4 provides a summary of students who engaged in the study and identifies them with a pseudonym for privacy and confidentiality. Pseudonyms were created from the first letter of students' last name and then selected from a list of popular baby names in 2019 (Huffington Post, 2019).

**Table 4:**

*Student Participants*

<b>Participant #</b>	<b>Pseudonym</b>	<b>Gender</b>	<b>Major</b>	<b>Year</b>
1	Caleb	Male	Mechanical Engineering	Junior
2	Anna	Female	Biological Engineering	Senior
3	Thea	Female	Computer Science	Junior
4	Claire	Female	Computer Science	Senior
5	David	Male	Mechanical Engineering	Senior
6	Wren	Female	Computer Science	Senior
7	Thomas	Male	Computer Engineering	Senior
8	Hazel	Female	Biological Engineering	Senior
9	Ryker*	Male	Electrical Engineering	Junior
10	Julia	Female	Mechanical Engineering	Senior
11	Ben	Male	Mechanical Engineering	Junior
12	Jane	Female	Computer Science	Senior

<b>Participant #</b>	<b>Pseudonym</b>	<b>Gender</b>	<b>Major</b>	<b>Year</b>
13	Nolan	Male	Electrical Engineering	Junior
14	Alice*	Female	Mechanical Engineering	Senior
15	Rose	Female	Biological Engineering	Senior
16	Cora	Female	Civil Engineering	Junior
17	Xavier	Male	Computer Science	Senior
18	Elise	Female	Biological Engineering	Senior
19	Henry	Male	Mechanical Engineering	Senior
20	Noah	Male	Computer Engineering	Junior
21	Kai* <sup>+</sup>	Male	Mechanical Engineering	Senior
22	Lily	Female	Civil Engineering	Junior
23	Charlie	Male	Mechanical Engineering	Senior
24	Sebastian <sup>#+</sup>	Male	Computer Science	Senior
25	Liam	Male	Civil Engineering	Senior
26	Grace	Female	Civil Engineering	Junior
27	Luke	Male	Civil Engineering	Junior
28	Mae*	Female	Civil Engineering	Senior

Note: (\*) First Generation (#) International (+) Non-White

### 3.7. Overview of Study

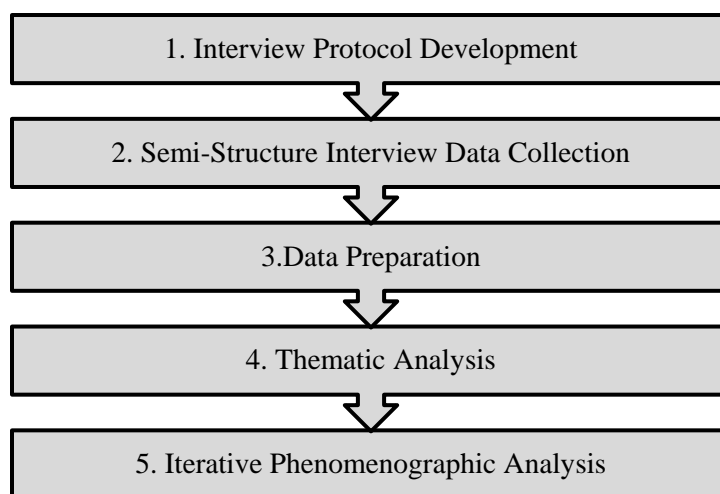
To investigate the research questions outlined in section 3.1, this study applied a phenomenographic methodology. Key attributes of this methodology include: (1) the qualitative investigation of a phenomenon through lived experiences; (2) collection of rich descriptive data through semi-structured interviews; (3) exploration of differences in these experiences to better understand the phenomenon; (4) development of categories of description and an outcome space to represent the phenomenon (Åkerlind et al., 2005).

The attributes are addressed through five phases, as illustrated in Figure 7, and are

outlined in detail in subsequent sections. Prior to conducting this study, human subjects' approval was received from the Institutional Review Board (IRB) at Utah State University. Documentation of this approval is provided in Appendix A.

**Figure 7:**

*Study Phases*



### **3.8. Interview Protocol Development**

In phenomenography, scholars emphasize the development of the interview protocol as a component that supports the rigor of the study, and as such, the interview protocol should be a carefully developed component of data collection (Åkerlind, 2008; Tight, 2016). Bowden and Green (2005) argue that, for this protocol to be effective, it must clearly introduce the phenomenon being explored, and all questions must maintain a consistent focus on the goal of the research question. Because data analysis in phenomenography relies on direct interpretation of evidence within the interview transcripts, it is critical that the interview protocol accurately investigates the

phenomenon (Åkerlind et al., 2005). Additionally, in order to reduce researcher bias, the research must do their best to stick to the script provided in order to reduce the influence students responses during the interview process (Bowden & Green, 2005).

As the interview protocol is a critical tool in phenomenographic data collection, it is recommended that the researcher use a multistep process to develop this tool. Yeong et al. (2018) recommend four steps to this process: (1) ensuring alignment between the protocol and research questions; (2) constructing an inquiry-based conversation; (3) receiving feedback on the interview protocol; and (4) pilot testing the interview questions. Integrating these steps of interview protocol development reflects the approach recommended by Åkerlind et al. (2005), and was used to ensure consistency and rigor in the interview process. Each of the steps undertaken in development of the interview protocol for this study are described in the following paragraphs.

The first step of this process (ensuring alignment between the protocol and research questions) was conducted by the researcher in the development of initial drafts. Questions within these drafts were checked against the conceptual framework of empathic concern in helping relationships described in chapter two, and the research questions provided in sections 3.1. To address the second step of the process (constructing an inquiry-based conversation) and support rich dialogue, the researcher refined the academic language in the protocol to reflect daily discourse and ensure that the phrasing of the questions would be accessible and understandable to students. This version of the protocol (version 2) was submitted to the dissertation committee and submitted as an amendment to the Institutional Review Board (which was later approved) as part of the dissertation proposal. To address the third step in the process (receiving feedback), feedback from

members of the dissertation committee was gathered. The feedback on this initial version of the protocol was incorporated prior to engaging in pilot interviews as part of the fourth step of the process. To address the fourth step of the interview protocol development (pilot testing interview questions), the researcher engaged in several rounds of pilot interviews to rehearse the interview process and further refine the interview protocol.

Conducting pilot interviews provided valuable practice for the researcher to improve interviewing skills and continue to tailor the interview questions as suggested by Bowden and Green (2005). The first round of pilot interviews was conducted with peers who are currently graduate students in engineering education. As these individuals have had experiences as engineering students and are familiar with qualitative research practices, their feedback provided valuable insight for improvements to the protocol. This feedback was included in versions 3 and 4 of the protocol. These changes included the addition of questions, which would allow the participant to describe experiences where students wished professors had shown empathic concern and questions that explored the expression of empathic concern in both one-on-one and group settings. Changes to this version of the protocol were revised for clarity, and version five was again sent to the dissertation committee for feedback. This process further supported steps one and three of interview protocol development described by Yeong et al. (2018).

Based on the feedback provided by the dissertation committee, the questions were shifted to a more neutral tone, and the opportunity to skip or pass on questions that students did not have experiences with was added. Additionally, a greater emphasis was placed on exploring expressions of empathic concern in class or group settings. Contextual questions about the course or setting where empathic concern was expressed

were also added. Finally, a summary question (“After thinking about these experiences, can you summarize what empathic concern looks like in your engineering education experience?”) was added as a way for students to reflect on their views of empathic concern in engineering programs. As phenomenographic interviews are often a reflective process for participants, the addition of this question allows students an opportunity to think about the underlying meaning of experiences discussed in the interview (Bowden & Green, 2005). These updates were implemented in versions six and seven of the interview protocols.

Following these revisions, the interview protocol was further piloted with three undergraduate engineering students who more closely reflected this study’s intended population. This process is highlighted by Bowden and Green (2005) as an important component of preparing for phenomenographic interviews. Through these interviews, the flow of the introductory paragraphs was improved to acknowledge that experiences described by students may represent challenges in their engineering programs, and to emphasize a safe space to share these experiences confidentially. This preamble was intended to support the creation of a comfortable environment for students to share their experiences (Dringenberg et al., 2015). Additionally, the reflective prompt provided at the start of the interview was refined for clarity. These revisions were included in versions eight and nine of the protocol.

After conducting the pilot interviews, the researcher reviewed the recordings to ensure that participant responses aligned with the intention of the research questions. It is important to note that data from these interactions were used to support the interview protocol development but were excluded from the data set. Final revisions were made to

the protocol and version 10 was submitted to the IRB for final approval, which was received on October 25, 2019. This version of the interview protocol can be found in Appendix C, and an overview of the protocol is provided in the following section.

### 3.8.1 Interview Protocol Description

The interview protocol utilized in conducting this study includes 12 questions, with follow-up and sub-questions to explore students' experiences of empathic concern expressed by professors in engineering. The interview process starts by asking student to review the following reflective prompt:

*As you prepare for your interview, take some time to think about your undergraduate courses. Within those courses, reflect on whether an engineering or computer science professor ever demonstrated **empathic concern** towards you as a student, or towards the whole class. **Empathic concern** is demonstrated by expressing compassion, understanding, or non-judgement.*

This prompt was provided to students in the e-mail confirming their interview time and on a slip of paper at the start of the interview session. Providing this prompt was meant to clarify the specific phenomenon being studied as students may interpret differently the broad conceptualizations of empathy. This allowed for deeper investigation of a predefined phenomenon as described by Ashworth and Lucas (2000). In addition, consistent use of an introductory scenario at the start of each interview ensured that each participant received the same information about the phenomenon from the interviewer (Bowden & Green, 2005).

Following review of the reflective prompt, the interview continued with an introduction to the study's purpose and procedures. Introductory questions about the

student's background, including program major and any extracurricular activities, were asked to build rapport with the student. These questions are intended to create a more relaxed atmosphere, which will allow students to reflect deeply on their experiences (Bowden & Green, 2005). Following these introductory questions, the participant was asked to describe what the concept of empathic concern means to them within the context of their engineering programs. Subsequent questions in the interview protocol asked students to describe concrete experiences with empathic concern that professors expressed towards them individually or towards a whole class. Asking participants to describe their own direct experiences with the phenomenon often highlights greater detail and allows for identification of important variation across these experiences (Bowden & Green, 2005). Follow-up questions were included in the protocol to understand the course context and how the components of empathic concern (understanding, non-judgement, and compassion) were expressed in each of the experiences described by students. To understand more implicit expressions of empathic concern, students were asked to describe course rules or policies that indicate empathic concern. Students were then invited to describe an experience where they wished a professor would have expressed empathic concern.

Additionally, after describing specific examples students were asked how these experiences of empathic concern impacted their experiences in undergraduate engineering programs and if empathic concern has a place in engineering education. Finally, students were asked to summarize what empathic concern looks like in their engineering education experience. As this process is often reflective for participants, the

inclusion of a summary question at the conclusion of the interview allows students to reflect on what they have discussed in the interview (Akerlind, 2005).

The structure of the interview protocol allowed for deep investigation of students' experience of empathic concern expressed by professors in engineering programs. In addition to the questions provided in the protocol, the researcher used follow-up question such as, "can you tell me more about that?" and "can you explain what you mean by....?" to encourage self-reflection and gather more details of participants' experiences. This strategy is common in phenomenography; however, it is critical that the researcher take precautions to "avoid adding their own concepts or ideas to the interview in an unplanned way" (Bowden & Green, 2005, p. 36). This skill was supported by the rehearsal and pilot interviews conducted as part of the interview protocol development. It is also important to note that the interview protocol served as a guide for semi-structured interviews. This type of interview uses a pre-established set of open-ended interview questions as a guide (Given, 2008), and as such, there is flexibility for the researcher to change the order of the questions based on the flow of the conversation. Implementing this type of protocol, as well as follow-up questions, allowed for collection of in-depth descriptions of student experiences of empathic concern the expressed by engineering professors. Procedures for collection of this data are described in the following section.

### **3.9. Data Collection**

The semi-structured interview is a significant component of the phenomenographic methodology and is emphasized by many scholars as the primary method for data collection (Akerlind, 2005; Åkerlind et al., 2005; Tight, 2016). This type of data collection allows researchers to investigate individuals' experiences with the

phenomenon while also eliciting the underlying meaning of these experiences (Akerlind, 2005). This is done through thoughtful development of a semi-structured interview protocol and the researcher's strategic efforts to reduce bias and make the participant comfortable during the interview process. Collection of in-depth descriptions of individuals' experiences with the phenomenon through semi-structured interviews allows the researcher to step into a students' world view thereby coming to understand their perception of the experience (Ashworth & Lucas, 2000). By collecting this type of data from a broad range of participants, multiple perspectives are represented and variations in experiences can be explored to provide a deeper understanding of the phenomenon (Marton, 1986). In conducting this study, 28 undergraduate students currently enrolled as juniors or seniors in engineering or computer science majors at a larger western university were interviewed. Following a review of the interview transcripts, which is described in section 3.10, one interview that included biased questions from the researcher was removed, and the number of participants was reduced to 27. These interviews gathered rich qualitative data that describes students' experiences of empathic concern expressed by engineering professors.

Prior to being interviewed, students who were interested in participating in the study were asked to respond to a short Qualtrics questionnaire, which was provided as a Quick Response (QR) Code and link on recruitment e-mails and flyers. This questionnaire included an IRB approved letter of consent and a short demographic questionnaire. Before participating in the study, students were asked to review the informed consent and agree to participate by providing their name and the current date within the online form. If an individual chose not to participate, they were not asked to

further participate in the questionnaire. After reviewing and signing the informed consent, students provided demographic information including their age range, race, ethnicity, and self-identified gender. In addition, students were asked about their educational standing, including their undergraduate major, engineering department, class rank, and any engineering student organizations they are involved with. The approved letter of informed consent and Qualtrics demographic questionnaire can be found in Appendices D&E.

After completing the questionnaire, the researcher contacted students interested in participating to schedule an interview time. To provide as much flexibility with scheduling as possible, the researcher provided access to possible interview times via the Calendly Scheduling Website ([www.calendly.com](http://www.calendly.com)). Using this website, students could sign up for a time and location (conference room, library, or other) that was most convenient to them. These practices were intended to help the participant feel comfortable in sharing their experiences, a critical element of phenomenography as described by Dringenberg et al. (2015). Students were also provided with the opportunity to engage in these interviews via videoconference, although no participants took advantage of this option.

Each student who scheduled an interview received an e-mail confirming their interview time. Within this confirmation e-mail, students were provided with a description of the project and asked to reflect on their experiences of empathic concern. The e-mail included the reflective prompt described on page 72. This prompt was intended to provide students with an opportunity to think about specific experiences where professors have expressed empathic concern before being in an interview setting.

By explicitly providing a definition of the phenomenon, the specific conceptualization of empathy being used within the study was clarified so that each participant was aware of the phenomenon being investigated (Bowden & Green, 2005).

Semi-structured interviews with 14 male and 14 female students from a variety of disciplines in the College of Engineering and Computer Science majors were conducted in person on the campus of a large western university during a six-week period between November and December of 2019. Interviews ranged from 24 to 59 minutes in length, and audio recordings were collected to ensure accurate representation of students' experiences. In addition, the researcher took notes and created reflective memos following each interview. This allowed for reflexivity in the interview process to reduce the potential influence of the researchers' own experiences with empathic concern (Bowden & Green, 2005). Following data collection, the interview recordings and demographic data were stored on a secure server, according to university policy, to support confidentiality and privacy of students. Through these semi-structured interviews, the researcher gathered rich qualitative data to explore the multiple ways students may have experienced empathic concern expressed by engineering professors.

### **3.10. Data Preparation**

Following the collection of data through semi-structured interviews with students, the researcher engaged in a rigorous process to prepare the data for further analysis. This process helped the researcher become familiar with the data and students' experiences before beginning data analysis. While it is ideal that the researcher become familiar with the data through a transcription process (Dortins, 2002), constraints on a researcher's time and responsibilities prohibited this initial process. An acceptable alternative was the

use of an IRB-approved, third-party transcription service to provide rapid turnaround of the transcripts (Bowden & Green, 2005). For the purposes of this study, the transcription service, Speechpad, was selected to provide verbatim transcription of the 1032 minutes of audio recordings collected during 28 interviews. This level of transcription supports “analysis [that] focuses on providing an in-depth description of the knowledge, attitudes, values, beliefs, or experiences of individuals” (McLellan et al. , 2003, p. 67), which is necessary for this phenomenographic study. All 28 interviews were transcribed and stored in a secure file according to Utah State University guidelines.

The researcher then engaged in a rigorous process to become familiar with the transcripts in preparation for data analysis. This three-step process included checking transcriptions for accuracy, checking for interview questions or responses that may have been outside the scope of the project, and de-identifying information. The first round of review focused on ensuring the accuracy of the transcriptions in comparison with the audio recordings. To do this, the researcher listened to each audio recording and made any necessary changes to the transcribed text. These changes included correcting any discrepancies between the audio recording and the text. For example, “too” was changed to “2” in a student’s description of the second course in the physics sequence.

Additionally, review of the audio in comparison with the transcripts helped to ensure that pauses and statements were included which capture students’ emotions. For example, the researcher included the phrase “I feel like.... I feel like I learn more,” in a student’s transcript to more accurately reflect the audio recording. MacLean et al. (2004) suggest this process can improve transcription accuracy, especially when working with multiple transcriptionists or transcription services, as Speechpad does. In addition to reviewing the

transcripts' accuracy, at this point, the researcher removed the introductory statements made by the researcher, which were the same for each interview, to allow for easier document review.

During the first review of the transcripts, the researchers noticed the introduction of ideas or questions which were outside the scope of the interview protocol. In phenomenography, it is critical that the researcher focuses on experience or conceptions of the phenomenon introduced by the participant (Ashworth & Lucas, 2000; Bowden & Green, 2005). In order to maintain participant voices and perspectives, during the second phase of data preparation, each interview underwent a review process to exclude sections where the researcher introduced questions or responses that were outside the scope of the interview protocol. In this phase of data preparation, the transcripts were reviewed for instances where the interviewer: (1) introduced a new idea or concept that was not included in the interview protocol or that was not previously discussed by the participant; (2) asked a potentially leading question, which could have been perceived as having a "correct" answer; or (3) drew conclusions that were beyond the initial ideas the participant presented. Each of these instances were reviewed, and any sections deemed as reflective of the interviewer's ideas were excluded from analysis. This process is reflective of the interview transcript reviews described by Hagens et al. (2009). The process for evaluating sections of the interview transcripts is detailed below.

To evaluate the data, the primary researcher engaged in a collaborative intercoder agreement process with another qualitative researcher familiar with interview analysis. Engaging in this process helped the researchers collaboratively define inclusion and exclusion criteria and apply these criteria to sections of the transcripts where the

researcher inserted their perspective. The inclusion and exclusion criteria developed, along with examples, are described more explicitly in Appendix F. The inclusion criteria contained any questions or information that is indirectly related to the concepts presented as part of the conceptual framework or the interview protocol. Additionally, the inclusion of criteria allows for any follow up or clarifying questions related to ideas the participant brought up. Excluded areas consist of situations where the interviewer (the primary researcher) introduced new ideas, such as rigor or motivation, which are outside the scope of the research questions. Additionally, any instances where the question could be considered leading or the interviewer introduced new ideas were excluded.

An initial round of intercoder agreement was conducted collaboratively on five different interviews (18% of the data). During this collaborative process, the entire interview transcription was reviewed, and any sections in question were discussed and labeled with an inclusion or exclusion rationale. Further, the text of any excluded areas was changed to a light grey color, indicating it should be ignored during data analysis. If a section was marked to be excluded, the question, participant response, and any follow-up questions or responses used before the researcher returned to the pre-established questions in the interview protocol were greyed out and excluded from analysis. An example of this is provided in Figure 8.

**Figure 8:***Sample of Excluded Text from Interview Review*

352 [Exclusion criteria: New idea - Rigor (Line 352-371)]  
 353  
 354 Interviewer: Do you think that by extending that deadline it reduces the rigor of  
 355 what's happening in class?  
 356  
 357 Claire: No, I don't think so. I think it could if... Let's see, I'm trying to. I think there  
 358 is potential for it if it conflicts with other deadlines. So, her extending this  
 359 deadline, it was only like two days extra or three days extra, but it didn't conflict  
 360 with pushing back any other of the deadlines. So other stuff was still due, but  
 361 they kept their deadlines but this one just got an extension. So, I think if  
 362 professors start like, "Oh, well, we'll have this due here and then we'll extend the  
 363 deadlines for these." And then that kind of makes, I think the rigor of the class  
 364 environment decrease.  
 365  
 366 Interviewer: So, if it is a continual rather than it being an exception, it's like it  
 367 just snowballs. One into the other.  
 368  
 369 Claire: Yeah. Exactly. If it snowballs, I think it decreases the rigor of the course.  
 370 But if it's just like one time, then it doesn't or a couple of times, but it doesn't  
 371 conflict with other due dates.

In the second round of analysis, the primary researcher utilized the inclusion and exclusion criteria established through the collaborative process to review the remaining 23 interviews. Areas in question were highlighted, and inclusion or exclusion rationale were provided for each section. During this process, the primary researcher asked for support from the secondary researcher in reviewing four additional interviews. In total, 32% of the data was reviewed collaboratively and 100% agreement on inclusion or exclusion of sections was reached through discussion.

As part of this review, the researcher observed that a significant portion of the interview with Participant #3 – Thea, was marked to be excluded from data analysis due to suspected bias during the interview process. This suspicion of bias was shared with the

secondary researcher and my faculty advisor. Upon reviewing the interviews and transcripts, there was mutual agreement on the presence of this bias. This suggests that the interview does not accurately reflect the participant's views, and as such, this interview was excluded from further analysis. It was at this point that the Participant # 3- was removed from the collective data set and subsequently, the number of participants in the study was reduced to 27 and this particular interview was removed. Data in the remaining transcripts that was marked to be excluded due to bias was limited, which suggests that the rest of the interviews still accurately reflected students' experiences of empathic concern. Work by Hagens et al. (2009) suggest that this interview review process has minimal impact on the specific outcomes of the study and support the use of the collective transcripts for data analysis.

The researcher conducted a third and final review of the transcripts to de-identify the data and ensure consistency in formatting. During this process, a common header was added describing basic demographic information about the participants (McLellan et al., 2003). Additionally, to support confidentiality and privacy, any identifying information including participant's name, student organizations, course number, course title, or instructor name, were replaced in the transcript with a pseudonym or descriptive label, such as CS Professor 1 (MacLean et al., 2004). In the process of de-identifying data, the researcher noticed common instances of courses and instructors across multiple transcripts. Therefore, a common notation for each individual or subject was identified and used across the group of 27 interviews. This helps to identify experiences across interview which are common to a professor or course. Finally, additional formatting, including application of line numbers, was applied to each transcript. All changes to the

original transcripts were tracked up to this point. Upon finalizing the documents to be utilized in the data analysis, all file edits were accepted, and a clean version was stored in a secure server according to the policies of research institution where this study was conducted. Undergoing this rigorous process of data preparation allowed the research to become familiar with the collective experiences that students described, before beginning data analysis.

### **3.11. Data Analysis**

Two phases of data analysis were used to address the research questions associated with this study and to explore students' perspectives of empathic concern expressed by professors in engineering programs. The first phase of data analysis involved creation of reflective memos, which summarized students' experiences and development of descriptive codes for these experiences. This phase of the analysis focused on exploring students' experiences within the context of the conceptual framework. This addresses the first research question, which investigates how the components of empathic concern (understanding, non-judgment, and compassion) were identified among the students' experiences.

The second research question of this study is addressed through the second phase of data analysis, which utilized iterative phenomenographic analysis. This analysis supports the investigation of the students' qualitatively different experiences of empathic concern expressed by professors in engineering. Investigating this phenomenon through the variation of individual experiences provided a deeper understanding of the phenomenon.

### **3.11.1 Phase 1: Thematic Analysis**

The first phase of data analysis was conducted over a two-week period and involved an in-depth review of the interview transcripts and creation of an experience summary for each participant. These summaries, which are each 1–2 pages in length, are supported by direct quotes from students and include the researcher’s interpretations of major ideas within the transcripts. This process is reflective of the summary process used by Daly (2008) in her phenomenographic investigation of design experiences, and is described in phenomenography as “condensation” or “reduction” of the data (Han & Ellis, 2019; Tight, 2016). Saldaña (2016) describes this process as theming and suggests it is an appropriate way to reflect on participants’ meaning-making and outcomes, particularly when the research is intended to “gain a deeper understanding of the nature of our everyday experiences” (p. 199). Developing these summaries required the researcher to reflect on, and condense, the ideas students described in the interview. In doing so, the researcher became more familiar with students’ experiences and themes represented in the collective data set. In addition to supporting the first phase of analysis, this process supports the first step in the iterative process of phenomenographic analysis in which the researcher immerses themselves within the data and creates reflective memos to track development of emerging themes and categories.

Following the development of participant summaries, the researcher returned to the full interview text and conducted a first cycle of descriptive coding. Short descriptive phrases were applied to identify experiences in passages of text (Saldaña, 2016). This led to the identification of 2–6 experiences within each interview. After the experiences were identified in the interview transcripts, an Excel file was created, and the experiences

described by each participant were listed. Experiences that were common across multiple participant interviews were identified with a specific color. This color coding of experiences across participants allowed for a visual representation of experiences common across the collective interviews. This process is referred to as code mapping and provides a way to organize and condense students' experiences to further study the central themes of the data and transition from the first phase to the second phase of analysis (Saldaña, 2016). A screen shot of the excel document provides an example of this for the first four experiences of Participants 1, 2, 4 and 5 is provided in Figure 9.

**Figure 9:**

*Example of Color-Coded Experiences from Phase 1 Data Analysis*

*(similar experiences are identified with the same color)*

#		Idea 1	Idea 2	Idea 3	Idea 4
1	Caleb	Professors who care about individuals and their learning/success	Professors who understand the difficulty of learning complex engineering concepts	Professors who are personable and know their students	Professors who recognize that students have a life and responsibilities outside of their engineering work
2	Anna	Professors who listen without judgement and do not minimize a student's emotional responses	Professors who are willing to change the pace of the course to make sure students understand	Professors who narrow the scope of information provided in lecture material	Professors who recognize that bad grades on a test may be their fault
4	Claire	Professors who place an emphasis on understanding rather than completing the requirements of the course	Professors who are willing to be flexible with the pace of the course so they can place a greater emphasis on learning	Professors who make exceptions on assignments when students make a mistake and miss the deadline	Professors who are personable in class and share a little bit about their personal background
5	David	Professors who seek feedback from students on how to improve the course (exam homework, in-class lecture time)	Professors who adjust course material (example problems and homework assignments) to support areas where the students are struggling	Professors who create a dynamic and comfortable environment in the classroom	Professors who take the time to narrow down the material so students can focus on the important concepts rather than trying to memorize

These experiences were further explored through the lens of the conceptual framework. After reviewing the definitions provided as part of the conceptual framework, each key idea was aligned with a key component of empathic concern (understanding, non-judgement, or compassion). The key component identifies the component of empathic concern that is most prominent in a students' experience. Students recognized these key components of empathic concern as supporting professors' expression of empathic concern. This allowed the researcher to identify how the students currently identify the components of empathic concern within their experiences with engineering professors.

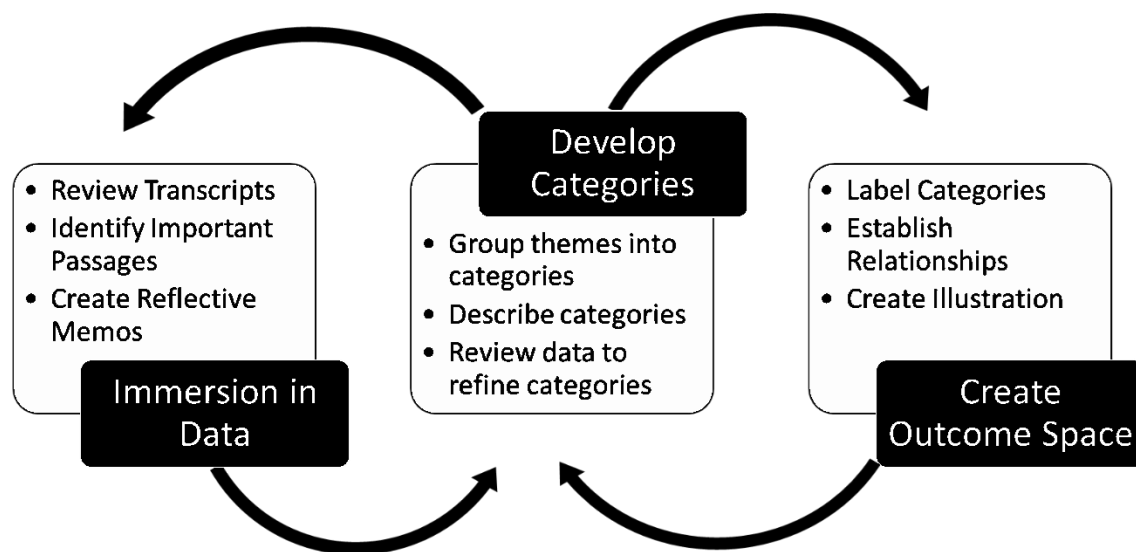
This initial phase of data analysis, which included reflective memos summarizing participant experiences, and first cycle coding to identify experiences and their relation to the conceptual framework, highlights how engineering professors expressed the components of empathic concern necessary for helping relationships. Further, this phase of data analysis supports the researchers' immersion into the data and identification of vital experiences. These experiences can be grouped to form categories of description; as such this phase of data analysis supports the iterative phenomenographic analysis conducted in the second phase of data analysis.

### **3.11.2 Phase 2: Iterative Phenomenographic Analysis**

Central to phenomenography is the iterative process of data analysis, which researchers use to more deeply understand students' experiences and identify variation in these experiences (Marton, 1986). This process supports the development of categories of description for the students' qualitatively different experiences with the phenomenon, and an outcome space that illustrates the relationship between these categories (Bowden &

Green, 2005). Work by Alsop and Tompsett (2006) suggests three steps in conducting data analysis in a phenomenographic study of information and communication technology in education. These steps include: (1) structured reading and re-reading of experiences to identify key experiences of the phenomenon; (2) identifying variation in these experiences; and (3) organizing these experiences into a structure. The iterative cycle of data analysis utilized in this study, which is consistent with phenomenographic research practices, is illustrated in Figure 10.

**Figure 10:** *Iterative Cycle of Phenomenographic Data Analysis*



The first step of the iterative process involves immersion into the data by reading and re-reading of transcripts. Reviewing the data as a collective whole allows the researcher to be faithful to the data in order to accurately represent the participants' experience (Bowden & Green, 2005). The first phase of thematic data analysis conducted

in this study allowed the researcher to become deeply familiar with the experience of empathic concern described in the collective students' interviews.

The second step in the iterative process supports the development of categories, which represents the qualitatively different experiences identified within the collection transcripts. Identifying experiences in the interview transcripts and organizing them through code mapping supports this initial step of the analysis. In further iterations of this step of analysis, it is critical for the researcher to focus on variation and differences in participants' experiences (Alsop & Tompsett, 2006). The goal with each revision is to further refine the categories to more clearly illustrate differences between experiences (Daly, 2008). In the third step of the iterative process, the researcher considers how the categories of description relate to one another, especially in a hierarchical context (Alsop & Tompsett, 2006). This step of the process should be conducted after the categories of description have been established so that the researcher does not impose a false hierarchy (Ashworth & Lucas, 2000). This iterative process of analysis is necessary to support rigor in phenomenographic studies (Bowden & Green, 2005).

Over the course of this research project, the collective interview transcripts were reviewed seven times through various stages of data analysis. Categories of description were drafted following each transcript review which lead to seven category iterations. In addition, to support reflexivity the researcher created a reflective memo following each analysis cycle. These memos helped to track the changes made in each iteration and allowed space for the researcher to reflect on their own experiences of empathic concern and express ideas or emerging categories. (Groen et al., 2017). Each iteration is briefly described below, and all seven category iterations can be found in Appendix H.

In the first category iteration, eight descriptive categories were identified. These categories were developed by grouping the key experiences identified in the first cycle of descriptive coding. This grouping reduced the number of experiences students described from 17 to 8 and was a preliminary attempt to identify the qualitatively different experiences of empathic concern engineering students described. However, Category 2 (professors who recognize students may have personal issues outside of their control and are willing to make accommodations) and Category 3 (professors who make exceptions when a student makes an “honest” mistake) were not specifically distinct from one another, while Category 4 (professors who build relationships with students and recognize them as individuals) is distinct but very broad. Additionally, one experience described by students identified empathic concern as professors responding non-judgmentally to students’ emotions, was left out of this initial iteration and is an important experience to capture, even if it only relates to a small number of students.

The second iteration identified eight categories. These categories were similar to those described in version 1. However, small changes were made to clarify students’ experiences. Specifically, professors who are personable in a lecture setting was moved to Category 4, which describes a focus on professors who care about their students. Assessment data is considered a form of feedback and is encompassed in Category 5. Creation of a dynamic lecture environment is included in Category 6 as part of course design. Finally, a distinction was made between professors who understand the challenges of engineering education (Category 7) and creating a safe space for asking questions (Category 8).

The third iteration attempted to reduce the number of categories and identified six categories. Along with creating these categories, an analysis was conducted to determine if combining categories was common across participants. This analysis was done by listing the categories each participant described and reviewing the list for similar patterns. This analysis showed that, while similar category combinations were rare (less than three of 27 participants), participants' experiences often overlapped multiple categories, with most participants (22 out of 27) describing experiences in more than half the categories. This suggests that the difference between experiences across categories is not clearly articulated, therefore there is a need to be more specific, and again, expand the number of categories.

In the fourth category iteration, seven categories were identified, and the nuanced differences between students' experiences started to emerge. This set of categories highlighted the importance of professors responding non-judgmentally to students' emotional reactions (Category 2), which is a distinct experience of only a small number of participants. In this iteration, professors creating a safe space to ask questions is lumped into (Category 7), which suggests that professors who understand the difficulty of engineering concepts express empathic concern. However, the participants' descriptions of these experiences did not always align with this category, so further revision was necessary. At this point in the iterative process, the categories of description became more consistent, and smaller changes in versions five, six and seven were used to further distinguish differences in student experiences. Version five shifted back to eight categories to describe student experiences of empathic concern in engineering programs.

It was at this point that the researcher noticed these categories could be grouped into three overarching themes and began to develop a rough design for the outcome space.

In order to further support rigor in this iterative process, 20% of the data, along with version six of the categories of description, were shared with another engineering education researcher familiar with qualitative data analysis. Based on these conversations, small tweaks were made to describe the categories more accurately in version six which included seven categories. Specifically, Category 2 was broadened to not only capture professors responding positively to emotional reactions, but also to encapsulate experiences where the professors made a human connection with students. This helps capture one of the experiences that was not well represented in the categories. Additionally, Category 7 was refined to focus on the environment that professors creates in a lecture setting, which establishes a safe space for asking questions. More clearly establishing these two categories helped to clarify the differences between the two groups.

To support the seventh and final revision of the categories of description, the researcher went through the interview transcripts and identified representative quotes for each category which support “pools of meaning” and help describe the categories of the phenomenon (Åkerlind, 2012 p. 326; Marton, 1981). Investigation of these themes through supporting literature helped to further describe the final version of the eight categories of description found in version seven. The final version of these categories was organized by overarching themes and used to create an outcome space that illustrates students’ experiences of empathic concern expressed by professors in engineering. These outcomes are further illustrated in the results chapter of this dissertation.

Implementation of this iterative phenomenographic analysis compelled the researcher to revisit the participants' collective experiences seven times. By exploring this data in-depth during each review, qualitative differences in students' experiences were identified and used to develop categories of description, which illustrate students' experiences of empathic concern with professors in engineering. As part of this process, eight distinct categories were identified.

### **3.12. Quality and Rigor**

Within phenomenography, quality and rigor are interpreted differently than in other methods of interpretive studies. While naturalistic inquiry emphasizes triangulation through collection of multiple data sources, prolonged engagement in the field, and member checking with participants (Creswell, 2013), phenomenography typically relies on a single data source (semi-structured interviews) and one round of data collection (Åkerlind et al., 2005). Instead of traditional approaches, phenomenography introduces quality and rigor and through detailed revisions of the interview protocols and procedures (described in section 3.8), iterative cycles of data analysis (described in section 3.11), researcher reflexivity (described in section 3.3), and checking outcomes with other researchers (described in sections 3.10 and 3.11) (Åkerlind et al., 2005). Additionally, study quality is demonstrated through transparency of the research process (described in section 3.5.6) and a consistent focus on the research question (described in section 3.1) (Tight, 2016). Details on the methods used to ensure quality and rigor within this study are discussed below.

### **3.12.1 Interview Protocol and Procedures**

The processes utilized for interview protocol development are articulated in section 3.8. Within this process, the researcher placed an emphasis on the development of a protocol that aligns to the proposed conceptual framework, establishes a clear definition of the phenomenon, and has been reviewed by advisors in the field, rehearsed with peers, and piloted with the study population (Bowden & Green, 2005). Engaging in this process supported improvement of the researcher's interview skills, which allowed the researcher to create a comfortable atmosphere for the participant to share their experiences.

Additionally, development of the interview protocol, and rehearsal of interviews, helped the researcher focus on following the protocol within the interview setting and use only general follow-up questions. This practice supports the accurate representation of student experiences within the interview (Ashworth & Lucas, 2000). To further support this, during the data preparation, the researcher reviewed each transcript to identify any instances where new ideas or questions outside the scope of the interview protocol were introduced. These sections were excluded from further data analysis (Hagens et al., 2009) to ensure the analysis focused on the description of experiences participants provided.

### **3.12.2 Researcher Reflexivity**

Within qualitative research, and specifically phenomenography, it was critical that the researcher recognized their own positionality and biases to accurately represent participants' experiences (Ashworth & Lucas, 2000). As an engineering educator, with teaching experience in both K-12 and higher education settings, I have experienced firsthand how empathic concern can be used in a course context. Within this research,

these experiences will help me to identify the nuanced characteristics of empathic concern that are needed to formulate the outcome space for this phenomenon. However, as part of the reflexive process, the researcher is expected to “step back consciously from her [sic] own experience of the phenomena and use it only to illuminate ways in which others are talking about it, handling it, experiencing it or understanding it” (Booth, 1997, p. 121). Within this research, I also recognize my positionality and worked arduously to be reflexive of my own experiences and biases with this phenomenon.

This process required the researcher to “bring into question their taken-for-granted presuppositions, misconceptions and biases” (p. 150) in order to more fully understand the participants’ experiences. This process is an essential component to phenomenography and phenomenology (Cibangu & Hepworth, 2016) and is considered a necessary approach to maintaining the quality of qualitative research in engineering education (Walther, Sochacka, et al., 2017). To address this, the researcher incorporated reflective memoing throughout the data collection and data analysis processes (Saldaña, 2016). The researcher created memos following each interview session and after each iteration of data analysis. These methods support the reflexivity of the researcher towards her own experiences and perceptions of the phenomenon in question in order to reduce bias and focus on the accurate representation of participant experiences (Tight, 2016).

### **3.12.3 Iterative Data Analysis**

Iterative phenomenographic analysis was used in this study to better understand the experience of empathic concern engineering students described. By completing the data analysis cycle multiple times, the researcher may confirm or challenge interpretations from prior cycles (Han & Ellis, 2019). Over the course of the research

study, seven iterations of this analysis were conducted. Each of these cycles allowed the researcher to engage with the collective interview data and to refine the categories used to describe participants' experiences. Following each iteration, the researchers documented impressions and questions as a reflective memo. Additionally, between the cycles of data analysis, the researcher stepped away from the work in order to return the process with more clarity, as is suggested by (Åkerlind, 2008). By developing the categories through several iterations, the nuances that distinguish the qualitatively different experiences of participants become more apparent (Bowden & Green, 2005).

#### **3.12.4 Collaboration with Researchers**

Bowden (2005) suggests that engaging with other researchers throughout the data analysis process can support the quality of the findings within phenomenographic research. In this research, the primary researcher worked collaboratively with a second researcher familiar with engineering education research and qualitative interview analysis to evaluate areas outside the scope of the research project, and to assess the accurate representation of experiences in the categories of description. These checks were conducted in both the data preparation phase and between the sixth and seventh iterations of data analysis. In both instances, more than 20% of the data was reviewed collaboratively with the intention that the second researcher challenged the preliminary outcomes developed by the primary researcher (Creswell & Miller, 2000). Discussion with the secondary researcher helped highlight nuances and built confidence in the accuracy of the primary researcher's findings.

## CHAPTER IV

### RESULTS

Qualitative phenomenographic analysis of interviews with 27 students enrolled in undergraduate engineering or computer science majors at a large western university were used to investigate students' experiences of empathic concern expressed by professors in engineering. These expressions of empathic concern may support the development of helping relationships between professors and students to improve students' experiences in engineering programs (Christe, 2013; S. A. Meyers, 2009). Research suggests that establishing these relationships can build rapport between professors and students and help to improve the engineering student retention (Geisinger & Raman, 2013; Vogt, 2008). Understanding experiences of empathic concern through students' perspectives will help to identify how professors express this phenomenon in engineering programs and provide guidance for educators wishing to further integrate empathic concern into their teaching practice. An overview of students' experiences and their perspectives on the role of empathic concern in engineering is presented in the first section of this chapter.

To better understand how empathic concern is used by professors in engineering, the first phase of data analysis explored how students identified the components of empathic concern, including understanding, non-judgement, and compassion, as necessary to support expressions of empathic concern. For each of the experiences described by students, a key component of empathic concern was identified. This analysis ties to the conceptual framework and addresses the first research question of the study. Results of this analysis suggests that all three components of empathic concern necessary

for building helping relationships are present in students' experiences of empathic concern from engineering professors. The components of empathic concern associated with students' experiences are presented in the second section of this chapter.

Building on experiences identified through thematic analysis, iterative phenomenographic analysis was used to further explore variations in students' experiences of empathic concern and address the second research question of this study. This analysis identified eight distinct categories of experiences of empathic concern described by engineering students. Each of the three components, which support expressions of empathic concern, were found to be integral in these experiences. The relationship between these experiences was explored, and student responses suggest that professors' expressions of empathic concern can be grouped into three overarching themes: (1) expressing care for students as individuals; (2) cultivating student learning; and (3) acknowledging the challenges of engineering education. These themes, and the resulting outcome space used to illustrate the phenomenon, are presented in the third section of this chapter along with detailed descriptions of each of the eight categories of experiences.

#### **4.1. Role of Empathic Concern in Engineering Programs**

Overall, students felt that empathic concern played an important role in their experiences with professors in engineering. All 27 students who participated in the study identified both experiences where a professor expressed empathic concern, and non-empathic experiences where they wished a professor had demonstrated empathic concern. However, students felt that professors who expressed empathic concern were more common than professors who did not express empathic concern.

Broadly, students felt that empathic concern helped professors to understand students' needs and provide support for these needs. One student briefly summarized this phenomenon as: "empathic concern would be a professor who understands what their students are going through and does their best to help the students get through that" (Elise—Female, Biological Engineering, Senior—Lines 830–832). Students felt that empathic concern supported professors' expressions of care for students as individuals and toward their classes. One student highlights the value of empathy by contrasting a professor who expresses empathy with a professor who did not really care:

I feel like they're such a better professor if they have more empathy. You know, whereas a professor that is only a professor and pretends to not be human, you know, I feel like they don't care about your grades. They don't care about you. They're just trying to get the work done. You know, but I think most professors really do care and really do have empathy (Hazel—Female, Biological Engineering, Senior—Lines 713–720).

Additionally, students felt that empathic concern supported human connections and rapport building between professors and students in engineering programs. These connections supported their participation in class and actively seeking help from a professor.

In describing their positive experiences, students suggested that expression of empathic concern supported their learning, motivation, and retention in engineering programs. Students highlighted these outcomes in the three following quotes:

***Learning:***

I think it [empathic concern] needs to have a place in engineering education because it'll foster more effective learning environments. I have had the greatest success, not necessarily grade-wise, but just retention of the information and where I finally felt, like, "Wow, I understand this." [...] I understand what's happening in the class. I feel that I have the tools to be successful and to solve these problems. And if I were given, like, a real-world problem, I can do that, were the times where empathic concern was shown in the class (Rose—Female, Biological Engineering, Senior—Lines 796–801).

***Motivation:***

So, definitely, the examples of empathic concern motivate me to continue because I feel like somebody cares about me, and about my learning. And so, if I feel like somebody cares, I'm far more motivated to try harder, and generally, my grades are better if I feel like somebody...if I feel like the professor cares (Luke—Male, Civil Engineering, Junior—Lines 413–418).

***Retention:***

I feel like it helps improve retention. Retention in school. That's my biggest thing because in my personal experience, if they [professors] were not as empathic as they were, I just wouldn't be able to stay here for another year by my own means. So even though I did four years of university and one year to graduation, I wouldn't have been able to complete it (Sebastian—Male, Computer Science, Senior—Lines 832–848).

In contrast to these positive examples of empathic concern in engineering programs, students felt that professors who had not expressed empathic concern deprioritize their students' success. Several students recognized that this may be due to conflicting demands on a professor's time between teaching and research, or due to the nature of larger course sizes. Caleb, a junior in Mechanical Engineering, highlights this conflict in his description of a non-empathetic professor:

So, not being empathetic would feel from a student's perspective like the professor isn't really concerned about my success as a student, whether it's learning the material, or a grade, or whatever it is, just not feeling like my success is a priority for them. Which is hard because some of the professors that are here are teaching because, they're here mainly for research purposes or they're trying to kind of figure out where they fit in with the education department. And so, their focus is on other things. And so, sometimes it can come through to the students (Caleb—Male, Mechanical Engineering, Junior—Lines 68–75).

Students primarily described non-empathic experiences, where they wished professors had demonstrated empathic concern in situations where a professor was not open to questions in classes or did not make exceptions on assignments. These experiences often demotivated students or discouraged them from engaging in classes. In some cases, experiences where a professor did not express empathic concern dissuaded students from further studying the topic that professor taught. David describes how the lack of empathic concern from a professor was discouraging:

And so, it wasn't a positive experience and it kind of put a taint on how I felt about the engineering program. [...] Up to that point, even though there were hard math classes and hard science and physics classes, it changed from something I was excited about to something that if it's gonna be like this with other professors or other experiences, that I'm just gonna have to get through it and deal with it and then I can move on with my life. And so, to a large extent, it kind of stunted a lot of the excitement that I felt for it [engineering] (David—Male, Mechanical Engineering Senior—Lines 591–598).

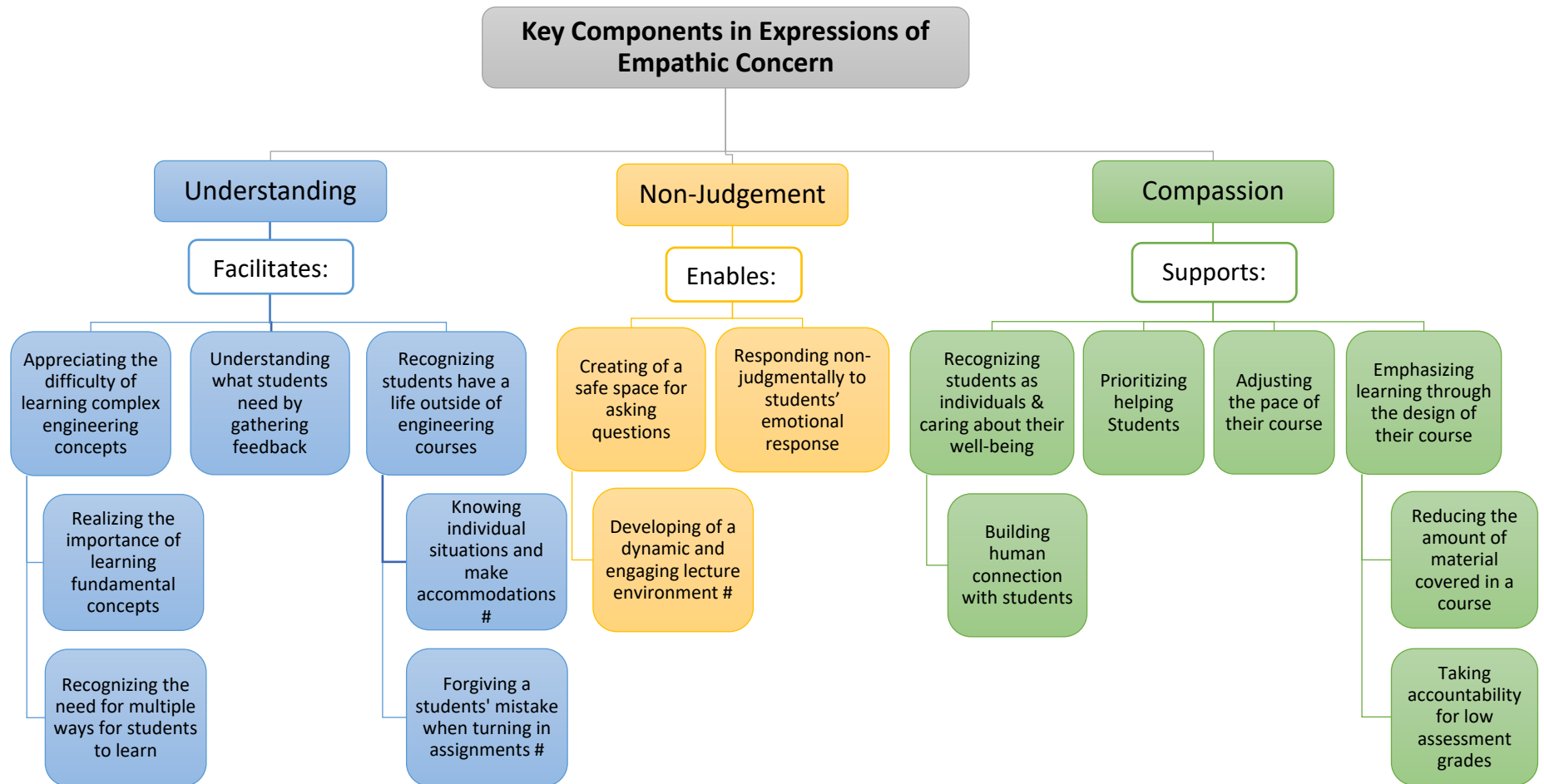
In some cases, students highlighted that empathic concern was not always consistent from professors in engineering programs but suggested that students can tell if a professor is trying to care or not. In summarizing his experience of empathic concern in engineering, David highlights the importance of professors who are trying to care, even though they may not always get it right:

Maybe just that it seems like good teachers are those ones that they're not perfect, but it seems like they are trying to help or they're trying to care. Yeah. They don't always maybe come across as caring or always help out when there are issues, but I think they're the ones that are trying to... Like, they're putting in a little effort on the side to think about how to better things for the students. And like I said, I don't think that they're always doing it and that they're always succeeding at it even, but I think that they're trying to. I think that makes the biggest difference because I think most people can perceive if someone is trying to care or if they're not. (David—Male, Mechanical Engineering, Senior—Lines 841–853).

#### **4.2. Components of Empathic Concern**

Semi-structured interviews were used to gather accounts of empathic concern experienced by undergraduate students enrolled in computer science or engineering majors at a large western university. These interviews asked students to describe their experiences of empathic concern expressed by professors in engineering and investigated how the components of empathic concern (understanding, non-judgement, and compassion) supported these experiences. Experiences that were similar across multiple interviews were then grouped, and 17 experiences of empathic concern were identified across the transcripts. As part of this analysis, students' experiences of empathic concern were explored through the lens of the conceptual framework of components of empathic concern necessary for establishing helping relationships. Each of the 17 experiences students described was associated with a key component of empathic concern which students felt supported a professors' expression of empathic concern. Figure 11 illustrates the organization of students' experiences with their associated key component of empathic concern (understanding, non-judgement, or compassion). Complete tables, including labels, and descriptions, for each of the 17 the experiences identified in the interviews further detailed in Appendix G and are illustrated in Figure 11. Of the 17 experiences of empathic concern described by students, three were supported by the key component of non-judgement, seven were supported by the key component of understanding, and seven were supported by the key component of compassion. Student perspectives on the key components which support professors' expressions of empathic concern are described in the following sections.

**Figure 11:** *Student Experiences Organized by Key Component of Empathic Concern and Its Outcomes*



# indicates a secondary component of compassion

#### 4.2.1 Understanding in Student Experiences

Understanding is an important component of establishing helping relationships as it allows an individual to actively engage in deeply understanding another's situation in order to understand the unique perspective of that individual (Kunyk & Olson, 2001; Rogers, 1961). In describing their experiences, students highlighted understanding as the key component of empathic concern that allows professors to "step into the shoes" of students and recall what it is like to be an engineering student. This component of empathic concern was identified as the key component that facilitates seven of the 17 student experiences of empathic concern. Students felt that professors demonstrated this component of empathic concern by recognizing the challenges of learning engineering concepts, working to understand their students' needs, and recognizing that students have obligations outside of their engineering courses.

Specifically, students suggested that understanding is the component of empathic concern that helps professors remember what it was like to be an engineering student, dealing with the demands of a rigorous program and learning new and complex material for the first time. One student summarized this in their description of an empathic professor as follows:

To me, a professor who has empathy is someone who can put themselves in your shoes and would treat you in a way that if the roles were switched, that they would want to be treated. So, they'd be able to understand just the workload of an engineering student. They would understand that you don't know what you're talking about yet. So, when you ask questions or try to elaborate, they would understand that you're not going to be completely technical because you're not

completely technical yet (Cora—Female, Civil Engineering, Junior—Lines 50–56).

Additionally, students felt professors who gathered feedback and input from their classes used the component of understanding to recognize their students' needs and provide additional support. They felt that this component of empathic concern facilitated professors being willing to provide extension or accommodation on assignments. Two students highlighted the key component of understanding in empathic concern as a professor who understands both an individual student's situation and the situation of the class as a whole:

I think overall, it's just understanding. If a teacher can understand the student situation, both individually and as a class. [...] I think that that, to me, is empathic concern because they can't change the material they teach, that needs to be taught. But understanding a student's situation or a class's situation is, to me, what empathic concern is (Xavier—Male, Computer Science, Senior—Lines 115–122).

I would say empathic concern is understanding of the student's situation. I guess that's in the definition, empathic. It's understanding. It's being able to read the room, understand that the students aren't getting what you're teaching, or maybe they're having a rough time, or they're overloaded with coursework, and it's proposing a change. Or even if you're not proposing some sort of change, just kind of being there is a resource. So, I guess in a short way of saying this, it's understanding and a willingness to do something, whether it be due dates, assignments being shortened or teaching another lesson on the course or on the

subject, sorry, or being available during the office hours. It's someone that we can hope to count on in a very, very rough program (Ryker—Male, Electrical Engineering, Junior—Lines 756–764).

Finally, students felt professors demonstrated understanding as part of empathic concern by seeing their course in the larger context of students' lives. This allowed professors to recognize that students have obligations outside of their engineering courses. One student illustrated this component of empathic concern in describing her experience with a professor:

I think he just understood that people wear multiple hats and sometimes you're a student and sometimes you're a mom, and sometimes you're a wife and sometimes you're a daughter and sometimes you're a friend and you can't wear all those hats at the same time. And he recognized that and said, "Hey, you can take off the student hat and not have it punish your grade." Which I don't feel like all professors necessarily do that (Julia—Female, Mechanical Engineering, Senior—Lines 103–108).

#### **4.2.2 Non-Judgement in Student Experiences**

Non-judgement is a key component of empathic concern essential to developing helping relationships. This component allows an individual to set aside their own beliefs and perspectives in order to create a safe space, without prejudice, for someone else to share their perspective (Rogers, 1975). Only three of the 17 experiences described by students relate to this component of empathic concern; however, students described these experiences powerfully. Students highlighted non-judgement as the component of

empathic concern that enables professors to respond positively in experiences where an individual student is emotionally distraught. In addition, students suggested that this component of empathic concern enables a professor to create a safe space for students to ask questions. Specifically, students felt non-judgement was critical in these experiences as it enabled professors to acknowledge students' feelings and validate their questions.

One student described the importance of non-judgement in her experience of empathic concern with a professor. In this situation, the student felt it was important for the professor to be non-judgmental by listening and acknowledging her feelings in a supportive way.

Yeah. I guess it would be, the willingness of a professor to hear and listen to what I'm saying and, I guess, not judge me for what I'm saying and understand that these are my feelings and that they are going to impact my ability to do work. And so, that if you can kind of help me to, work through them or get around them or whatever I need, you know, to be able to move forward, then you can point me in the right direction or specifically help me instead of minimizing them and saying, like, "You shouldn't feel that way" (Anna—Female, Senior, Biological Engineering—Lines 694–701).

Students felt that non-judgement in empathic concern enables professors to support students by acknowledging and validating their emotions. In addition, students thought the component of non-judgement was necessary for professors to acknowledge and validate students' questions in a lecture environment. Students suggested that a professor who responds non-judgmentally to questions can create a positive classroom environment where students feel comfortable asking questions. In discussing these

experiences, students often contrasted examples of judgmental experiences with non-judgmental experiences. Hazel, a senior in Biological Engineering, compares asking questions in courses where a professor expresses judgement, with a professor who is non-judgmental and validates students' questions in the following quote:

Where some classes, I'll raise my hand and ask a question, and they don't answer it, or they make me feel stupid for asking a stupid question, and then I'm like, "Okay. I'm done. I'm never raising my hand in that class ever again." Whereas when I have a class where I raise my hand and ask a question, and they give me a response that makes me feel like they've actually thought about my question, then I'm so much more likely to ask more questions (Hazel—Female, Biological Engineering, Senior—Lines 640–646).

#### **4.2.3 Compassion in Student Experiences**

Compassion is the component of empathic concern that relates to the actions or behaviors that demonstrate care or concern for an individual (Baston et al., 2002; Goleman et al., 2017). This component of empathic concern extends beyond the cognitive and affective forms of empathy, which allow someone to understand another's perspective or feelings and motivates an individual to want to help another person (Goleman et al., 2017).

Students highlighted this component of empathic concern in connection with experiences where a professor expressed care or concern. In describing their experiences students often translated the idea of empathic concern to expressions of care towards either individuals or towards the class. This component of empathic concern is associated with seven of the 17 experiences students described. This includes experiences when a

professor recognized students as individuals and prioritized helping them and experiences where the professor demonstrated concern for the whole class by placing an emphasis on learning.

Students described compassion as a key component in experiences of empathic concern where the professor demonstrated that they cared for students as individuals. These experiences helped students feel like professors cared about them as human beings rather than just a number in their class. One student's definition of empathic concern highlights this act of caring or compassion as a component of empathic concern:

I think empathic concern is when professors care for their students as people and as students. You know, like, they care that they're happy in their lives, but also that they're learning the things that they need to learn. And I think, you know, a professor that wants their students to do well and puts themselves in their students' shoes, and tries to make the situation, you know, comfortable for everyone, I think that's an empathic professor (Hazel—Female, Biological Engineering, Senior—Lines 678–683).

Additionally, students' responses suggested that professors show compassion in empathic concern by being concerned about the success of the whole class. One student recognized the key component of compassion toward the whole class in describing her experience with empathic concern in a senior level engineering course:

I know, for me, it feels like he cares how we're [the class] doing. And to me, it is a sign of compassion. He genuinely cares how we're doing and feeling in the course. And the fact that he's asking us so often where we're at. It's obvious, he cares about the students in this class. To me, it shows that he cares about the

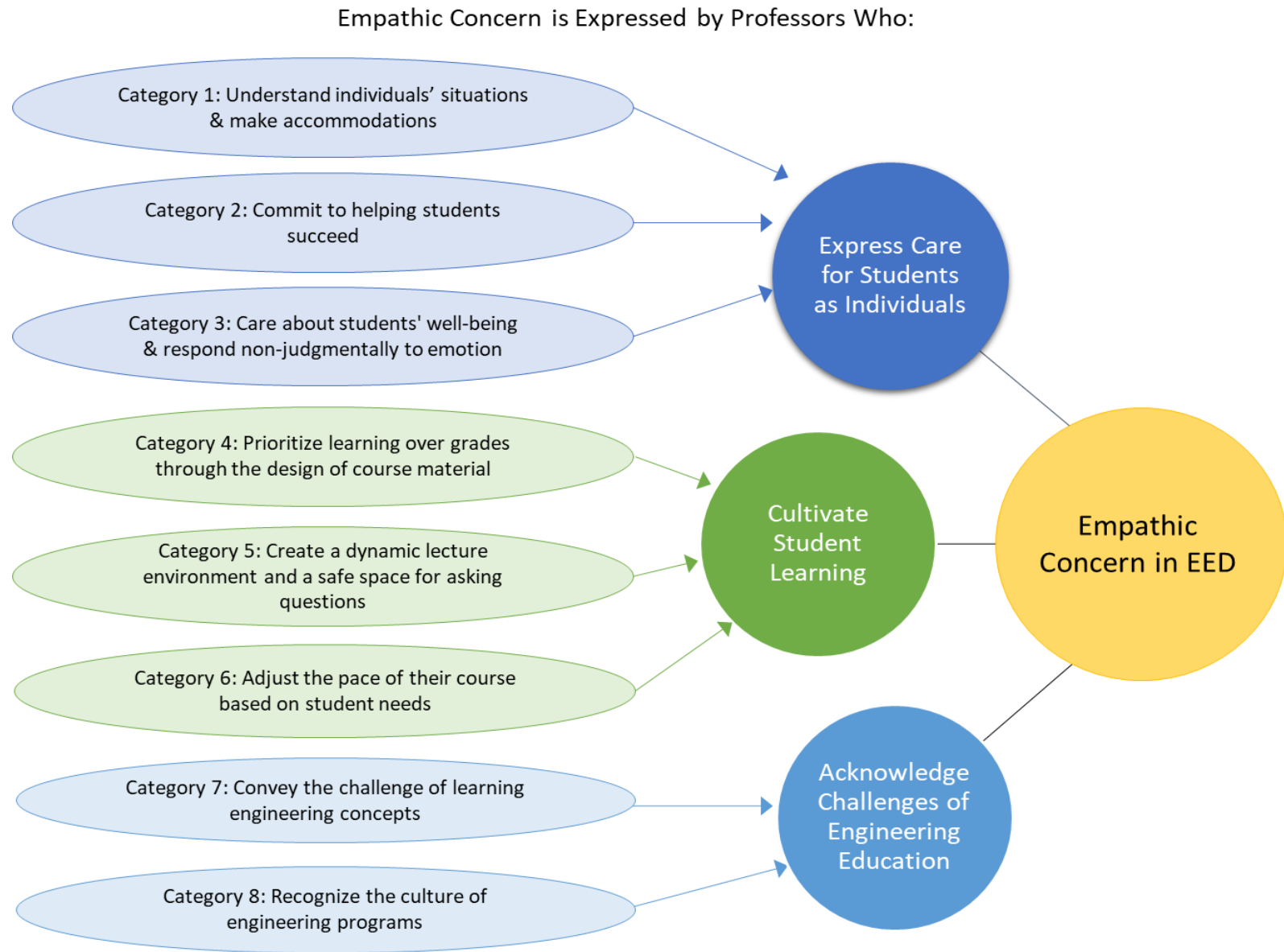
students in the class and he cares about how we're doing. And it shows that, when we are frustrated, he wants to give his time to make sure that we're not gonna be frustrated anymore (Elise—Female, Biological Engineering, Senior—Lines 297–303).

The experiences described in this section suggest that empathic concern is present in engineering programs, and the components of empathic concern necessary for establishing helping relationships, including understanding, compassion, and non-judgement, play an important role in supporting these experiences. The following section further explores student experiences of empathic concern and describes eight distinct categories of empathic concern identified through phenomenographic analysis.

#### **4.3. Categories of Student Experiences of Empathic Concern**

Following the first phase of thematic analysis, a second phase of iterative phenomenographic analysis was used to explore the variation in students' experiences of empathic concern. The original 17 experiences identified through thematic analysis served as a starting point for this analysis and were revised and reorganized to support the development of categories of description. Seven cycles of iterative phenomenography were used to investigate the collective transcripts. Through this analysis, the researcher identified eight distinct experiences of empathic concern that are captured by the categories of description. During the final cycles of iterative phenomenographic analysis, the relationships between categories were explored, and three overarching themes were identified. These themes and their associated categories are illustrated in the outcome space presented in Figure 12.

**Figure 12:** *Outcome Space for Experiences of Empathic Concern in Engineering Programs*



The following sections present each of the overarching themes and their associated categories that describe students' experiences of empathic concern in engineering programs. These sections include an overview of the theme, descriptions of each category, and quotations from the interview transcripts, which are used to help illustrate students' experiences and serve as a sample of evidence used in the development of categories. It is important to note that categories were developed based on the collective experiences described in the interviews. Thus, the quotes presented are intended to highlight key aspects of the category but represent only a portion of the evidence used to develop the category.

#### **4.3.1 Theme 1: Expressing Care for Students as Individuals**

The first theme highlights student experiences of empathic concern where they felt a professor demonstrated care for them as both a student and an individual. Students described three categories of experiences which align with this theme, including professors who take the time to understand student's individual circumstance and make accommodations, professors who commit to helping students succeed, and professors who care about students' well-being outside of their engineering program. Several students highlighted how these expressions of care in empathic concern impacted their experiences in engineering courses. One student, Ben, suggested that having one professor who cares about students' individual situations each semester helps students to survive in engineering programs. A second student, Caleb, suggests that professors who cared about him as an individual played an important part in motivating his learning. Their experiences are highlighted in the quotes below.

Having even one professor a semester that actually genuinely cares is enough to keep you, like, trudging through the mud and the slop that is engineering undergrad. If I had semester after semester of professors that are just rigider than steel and, and just like, "No, this is how it is. There's no fluctuation. I don't care if you're in the hospital getting your appendix removed. Like, if your homework is not on my desk at 9:00 in the morning, it's late, it's gone. Bye-bye." I don't know if I could take more than two semesters of that (Ben—Male, Mechanical Engineering, Junior—Lines 657–663).

And so, I think it's been hugely important at least in my learning, [..]. Any time I felt like the professors genuinely cared about me as a person and the things that I was learning, it added to the drive to wanna try and do better in their class. So, almost to kind of show appreciation like, "Hey, thanks for showing some empathy towards us. It was hard but I appreciate you trying to help us through it and whatnot" (Caleb—Male, Mechanical Engineering, Junior—Lines 534–540).

The overarching theme of expressing care for individual students encompasses three specific categories of experiences students described. These experiences include professors who: (1) understand students' individual circumstances and make accommodations; (2) commit to helping students succeed; and (3) care about student well-being and respond non-judgmentally to emotion. Details of the categories of description for experiences that support this theme are provided in Table 5.

**Table 5:***Theme 1: Categories of Description (1,2,3)*

Category	Professors Who:	Description	Participants	Component of Empathic Concern
Category 1	Understand individuals' situations & make accommodations	This is demonstrated by professors who see their course in the larger context of students' lives. They take the time to understand students' personal circumstances, including illness, family situations, travel, or mistakes, and are willing to be flexible with assignments and due dates so that students' grades accurately reflect their understanding.	<i>Total: 13</i> <i>(Female: 4</i> <i>Male: 9)</i> Claire, David, Wren, Ryker, Jane, Nolan, Alice, Xavier, Henry, Kai, Charlie, Sebastian, Liam	Understanding, Compassion
Category 2	Commit to helping students succeed	This is demonstrated by professors who are eager to help individual students outside of class time. They encourage students to come ask for help, have an open-door policy, or office hours which align with student schedules, and give students their full attention.	<i>Total: 14</i> <i>(Female: 8</i> <i>Male: 6)</i> Caleb, Anna, Claire, Thomas, Ryker, Rose, Cora, Elise, Noah, Lily, Sebastian, Grace, Luke, Mae	Compassion, Understanding, Non-Judgement
Category 3	Care about students' well-being & respond non-judgmentally to emotion	This is demonstrated by professors who strive to build human connection with students and care about their well-being as both a student and a person. In these experiences, professors take the time to listen, without judgement, to students' personal challenges, feelings or emotions, and often crying.	<i>Total: 8</i> <i>(Female: 8</i> <i>Male: 0)</i> Anna, Wren, Hazel, Julia, Jane, Cora, Lily, Mae	Compassion, Non-Judgement

***4.3.1.1 Category 1: Professors who understand students' individual situations and make accommodations***

This category represents students' experiences when a professor recognized students have obligations outside of their engineering courses and demonstrated compassion in making accommodations for an individual student's situation. Thirteen of the 27 students described this category of empathic concern, including nine male students and four female students. Jane summarized this type of experience as part of her definition of empathic concern:

I think it [empathic concern] kind of means someone who understands that, first off, that you don't only exist to take their class, and their class isn't the only thing that you're doing with your life. The teachers that I feel like demonstrate the most empathic concern are the ones that offer a little bit more leniency at times with things like due dates (Jane—Female, Computer Science, Senior—Lines 100–104).

Students felt that professors expressed this type of empathic concern when they took the time to listen and understand a students' personal circumstances. These circumstances could include illness, family situations, personal or school related travel, or mistakes when turning something in. In describing his experiences of empathic concern, one student, Charlie, emphasized the importance of this expression of empathic concern as he juggled academics and dealing with a chronic illness. He felt that professors who were willing to make accommodations due to his illness allowed him to get a grade that reflected his understanding of the material rather than limitations due to his illness. He highlights this in his experience in a sophomore level course:

It made me feel like that's the grade, that I should get because that's my understanding of the material. Not because I was sick [...] for three weeks at a time and I couldn't do the assignments. So, it was more of a sense of this is how well you understand the material and this is how well you did in the class, versus you just missed assignments because you were sick, so that's why you didn't do so well (Charlie—Male, Mechanical Engineering, Senior—Lines 484–489).

Additionally, students felt this understanding was especially important when they made a mistake turning an assignment in. Students often attributed these mistakes to an issue with the learning management system or an “honest” mistake when they turned in the wrong document, forgot a due date, or missed part of the assignment. One student described this type of experience in a required junior level course:

And I have had professors who wouldn't let you do that if you had made that mistake, but this professor did. And I was very grateful for that empathy and allowing me to do that because it was just an honest mistake. I had done the homework on time and everything. I just had forgotten that one part that was pretty important (David—Male, Mechanical Engineering, Senior—Lines 176–180).

Overall, students felt that professors who demonstrated understanding and compassion towards their individual situations recognized that sometimes challenges come up in life, which are outside of students' control. Rather than being punished for these situations, students felt that professors who showed empathic concern in this way supported them as they were doing their best. Students felt that professors who expressed empathic concern by taking the time to understand and accommodate individual students'

circumstances, better supported their learning and success. This category highlights experiences of empathic concern where a professor is able to see their course in the larger context of a student's life and express care and concern for students' individual circumstances. One student summarized this in two statements about an experience where a professor allowed him to turn in late work:

Every once in a while, something happens. Maybe events in your life that make it hard to meet the exact deadline. So, then to have still the possibility of getting credit for your work is a good way of showing empathy (Henry—Male, Mechanical Engineering, Senior—Lines 275–277).

I think there's a lot of hardworking students that intend to do their best yet still fall short. And having that opportunity [to turn in assignments] at least gives the student, in my case me too, [an opportunity to] still try to do their best. Otherwise, it kind of just seems like a failure if you missed it (Henry—Male, Mechanical Engineering, Senior—Lines 283–285).

#### ***4.3.1.2 Category 2: Professors who are committed to helping students succeed***

This category captures students' experiences of empathic concern when a professor demonstrated a commitment to helping students succeed. Students described this type of empathic concern in situations where professors were eager to help individual students outside of class time. Fourteen of 27 students described experiences in this category, including eight female and six male students. Students who described this experience of empathic concern felt that professors demonstrated a commitment to helping students succeed by encouraging them to come and ask for help and making

themselves available through office hours or an open-door policy. Rose describes this experience in a small senior level course while Mae highlighted the importance of this in a large sophomore level course:

And I feel like he showed compassion by taking time that he could have been working on his own individual projects and other work that he needed to be done outside of class. And took that time and spent it with me and, I mean, with the rest of our class as well. But specifically staying after class to meet up with me and answer those questions, I think was the biggest show of compassion because he could have been doing anything else with his time. Time is pretty valuable (Rose—Female, Biological Engineering, Senior—Lines 249–255).

I think just that willingness to have his office open. I think that's just so important just to know that there is an open office and knowing after having had that first experience, just being able to go back and knowing that there would be help and he was completely honest in his, "I want to help when I can and I want to help you succeed," and knowing that he really did want me to succeed (Mae—Female, Civil Engineering, Senior—Lines 182–186).

In describing experiences where professors demonstrated empathic concern by being eager to help, several students highlighted the importance of professors giving students their attention. Students felt that professors demonstrated this by giving students their full attention, listening, and being cognizant of what students' needs. Participants Luke and Elise highlight this in their description of experiences of empathic concern in sophomore level courses:

Despite his time constraints, he was still very willing to make time to meet with me and to discuss my situation and to work through that with me as long as it took. So, yeah, definitely, his whole approach to it, being very listening, cognizant of what I was thinking and what I was feeling (Luke—Male, Civil Engineering, Junior—Lines 181–184).

The biggest thing, I think, was, honestly, the fact that he just stopped what he was working on and just let me, like, talk. Because we probably looked at everything for, like, 20, 30 minutes. And he just stopped whatever he was working on. Like, I don't even know what it was. And he took this time to, like, go over the assignment, go over the test, and just talk to me about the class. So, yeah, I think stopping what he was doing and then just taking the time to, like, walk me through what I was missing (Elise—Female, Biological Engineering, Senior—Lines 167–173).

In contrast to these positive experiences, a student described a professor who did not show empathic concern as portraying their time as more important than students time.

I don't know. I mean, there are certain professors that you just see them and they're super serious and they act but...I mean, they don't act. They are really busy, and you just don't wanna bother them. They just portray that their time is more important than the students' time (Thomas—Male, Computer Engineering, Senior—Lines 366–368).

In positive examples of this type of empathic concern, students felt that professors made a commitment to helping students succeed. However, in non-empathic examples, such as

the one Thomas previously described, students felt that helping students was not the professor's top priority.

In addition to giving students their time and full attention, students felt that a non-judgmental approach is essential when helping students. One student described this as part of her experience of empathic concern when going over a test with a professor in a sophomore level class.

And then even when we were going through the test, like, he never made any comments because there was definitely a theme of questions that I was missing. It was obvious that I didn't understand the concept. But he never was like, "Well, why didn't you get it?" He just, like, showed me how to do it (Elise—Female, Biological Engineering, Senior—Lines 197–200).

In this situation, she had made consistent mistakes on the exam related to a particular concept. Instead of judging her lack of understanding with this concept, the professor focused on providing support in understanding how to correctly answer the questions. Another student, Jane, highlighted how a professor's positive and non-judgmental response helped her feel comfortable, and encouraged her to ask the professors questions directly:

I think that if you feel comfortable with a person, if you feel like they hear you, I feel like that is a teacher that has expressed empathic concern to you, and I feel like that creates the best learning environment, you know? Because you feel safe around them to say that I don't know something, or I didn't understand this, or when you get to a project and you're stuck, you can say, "This is where I'm at. Am I being dumb here?" when it's one really obvious thing. And I mean, you know,

obviously the tutoring lab and stuff, they can help you with that, but actually feeling okay to go to the teacher itself, I think that that's a very valuable thing (Jane—Female, Computer Science Senior—Lines 586–594).

Students described this type of empathic concern as an important part of the professors' teaching practice and felt that this expression of empathic concern could support a positive learning environment where they felt comfortable seeking individual help from a professor. This category is intended to capture student experiences of empathic concern where a professor demonstrates a commitment to helping students succeed by being eager to provide help for individual students outside of class time.

#### ***4.3.1.3 Category 3: Professors who care about students' wellbeing & respond non-judgmentally to students' emotions***

This category describes experiences of empathic concern when a professor demonstrated care or concern for a students' happiness or wellbeing beyond the context of their engineering program. In addition, this category includes experiences where a professor responded non-judgmentally to an emotionally distraught student. Eight of the 27 students, all of whom are female, described these types of experiences. In describing experiences of empathic concern in this category, students highlighted professors who took the time to listen to a students' personal challenges and feelings and responded positively in experiences where the student was crying. Hazel describes an experience of empathic concern from a professor when she was dealing with a friend's mental health issues and had stopped attending class. During the meeting, the professor focused on making sure Hazel could succeed in the sophomore level class and be happy in her life.

In addition, she appreciated that the professor took the time to understand and address the root of the problem rather than just get her back on track in his class.

And he's like, "Okay, let's take a minute. Forget about this class. What do you need to be able to, like get back on track in your life? You know, like, how can you...what do you need to be able to be happy?" You know. And he was like, "This class isn't important." [...] and just the fact that he was able to see beyond getting a good grade in his class, that I was a human being that needed to have a good life, and that was his first priority for me" (Hazel—Female, Biological Engineering, Senior—Lines 83–90).

You know, so, I was really grateful that he took the time to, you know, ask me questions about why I wasn't coming to class. What was keeping me from doing well in his class. Not just you know, here's how to go to TAs and like, he didn't just list off a bunch of things I should have been doing. He was like, "Okay, what is going on behind the scenes that you're not coming to class?" Which I really appreciated (Hazel—Female, Biological Engineering, Senior—Lines 121–126).

Additionally, students suggested that this type of empathic concern was demonstrated by professors who recognized there may be an emotional component of what a student is struggling with. Lily recognized the importance of professors' affective ability in these experiences of empathic concern:

I think when someone has empathy, whether it's a professor or someone helping you, a TA, something like that, it's that, I mean I think there's an emotional side of things where they understand sometimes things happen in life that makes class work a little bit more difficult, you can't be up to par and that changes with

everyone. So, being able to understand but not just give people, you know, free cards all the time but still understand that those situations are happening and be willing to listen and address them (Lily—Female, Civil Engineering, Junior—Lines 65–74).

Many of the students who described this type of empathic concern described a professor's response to their emotional distress, often expressed through crying. Cora described this experience with a professor and later highlighted the importance of this experience in building a relationship with that professor.

And so, I cried. I tried not to let him see. He totally saw. But then like in that situation, like he didn't point it out. He just continued to explain it to me. He was like, "It's going to be okay. We're going to get this figured out." He continued to talk to me, calm me down. And eventually, I was able to understand that concept while sitting down with him in that same time interval (Cora—Female, Civil Engineering, Junior—Lines 133–136).

Which like going from that experience, that could have been a big turning point based on how he reacted to that. Because if he would have reacted negatively, I probably would've never talked to him again. Because I kind of would've caved. But because he responded positively, it gave me the confidence to go to his office again and ask further questions and then going more often helped to build that relationship. And because it continued to be positive in those interactions, it just helped me continue to go and go and go and build that relationship (Cora—Female, Civil Engineering, Junior—Lines 167–174).

Mae, a senior in Civil Engineering, described a similar experience with a professor in a sophomore level class and highlighted how this professor responded positively to her crying. When asked to describe the components of empathic concern related to this experience, she highlighted the importance of not being judged, and in particular, the importance of this as a woman in engineering:

Firstly, he was okay that I was crying in his office. I was not expecting that and I was not expecting to have a professor that was very chill with that situation because I'm not chill with myself when that happens because I'm frustrated about this thing and then I'm crying so then I'm frustrated myself, which just adds to the problem. But he was very patient and just wanted to work through what was causing the problems. And I've had a lot of...I've had a few professors that I have unwillingly cried in their office hours and they just take a step back and say, "Okay, what's the problem and where are you struggling," and then proceed to help find a course of action to make it better (Mae—Female, Civil Engineering, Senior—Lines 142–159).

I think, firstly, sometimes it's like, "Oh, she's a woman and she's crying," but I didn't feel any of that and I didn't feel like I was being judged for being a woman in engineering or for that, just that day where I just was having a really bad day. And as well, he went on to say like, "Women are so much harder on themselves and when they're in the engineering program and like it's okay and you're doing what you can." And so just that understanding as well as just, again, being willing to listen (Mae—Female, Civil Engineering Senior—Lines 161–167).

This student's experience highlights the importance of this type of empathic concern for women in engineering. This category of empathic concern includes students' experiences when a professor demonstrates care or concern for a student's well-being outside of their engineering courses. In these experiences, professors take the time to listen to a student's emotions or personal challenges and respond non-judgmentally.

#### **4.3.2 Theme 2: Cultivating Student Learning**

The second theme describing professors' expressions of empathic concern in engineering programs highlights experiences when a professor cultivated student learning by placing an emphasis on learning over grades. The categories of experiences, which support this theme include professors who prioritize learning over grades through the design of their coursework, professors who create a dynamic lecture environment and safe space for asking questions, and professors who adjust the pace of their course based on student needs. These categories highlight the importance of placing an emphasis on student learning over completion of tasks or assignment of grades. One student summarized what this form of empathic concern should look like in engineering programs:

So, I think empathic concern within the engineering education system should look like a desire for the students to learn being the [professors'] number one goal, instead of high ratings or a high average grade or looking for tenure based off of any other measure. I think the number one goal is that the professor should have a desire for their students to learn what they're teaching. And I just kind of wanted to connect it back. [...] Essentially the compassion aspect of it is that they really

care enough for us that they have a desire for us to learn. And then to achieve that [there should be] be effective communication between the professor and their students that they're teaching. That can just be looking at the assignments or the test scores and seeing whether or not they need to spend a little more time on that material because the test scores weren't very high or listening to the students in, like, "Hey, I have a question or, like, I'm not fully grasping this material or, like, I'm not feeling like I have the tools I need to succeed or, like, where are you finding this information?" And just listening to all of that.

And then that kind of plays into, [professors] being open to change, which would be kind of my last key point. Listening to the feedback and not just listening but being willing to change something because of it. Like, if the test scores weren't very high, instead of just moving on to the next topic, taking maybe an extra day to talk about anything that the students missed and didn't feel very confident in. And so, reviewing that and helping solidify the material so that they actually learn it instead of just moving on and be like, "Well, the test happened so we're past that." Just being flexible enough, and open enough, and non-judgmental enough that if we're off from the timeline they had originally set, that they're willing to kind of change things up (Rose—Female, Biological Engineering, Senior—Lines 850–874).

Three categories of description highlight how professors currently express empathic concern by cultivating student learning in engineering programs. These categories (described in Table 6) include: (1) prioritizing learning through the design of

coursework, (2) creating a dynamic lecture environment and safe space for asking questions; and (3) flexibility to adjust the pace of the course based on student needs.

**Table 6:**

*Theme 2 - Categories of Description (4,5,6)*

Category	Professors Who:	Description	Participants	Components of Empathic Concern
Category 4	Prioritize learning over grades through the design of course material	This is demonstrated by professors who prioritize students' understanding of the material over the completion of tasks. This includes narrowing down material, allowing revisions and extra credit on assignments, evaluating assessments, providing a variety of learning resources, and setting clear expectations.	<i>Total: 12</i> <i>(Female: 5 Male: 7)</i> Caleb, Anna, David, Wren, Thomas, Julia, Ben, Nolan, Elise, Lily, Charlie, Liam	Understanding, Compassion
Category 5	Create a dynamic lecture environment and a safe space for questions	This is demonstrated by professors who create an open dialogue in their classroom, engage students in relevant examples or demonstrations, and respond positively to students' questions, including answering them without judgement.	<i>Total: 14</i> <i>(Female: 6 Male: 8)</i> Anna, Claire, David, Thomas, Ryker, Julia, Rose, Xavier, Elise, Henry, Noah, Kai, Liam, Grace	Non-Judgement, Compassion
Category 6	Adjust the pace of their course based on student needs	This is demonstrated by professors who are aware of where their students are at, either by asking for feedback or checking for understanding, and are willing to adjust the pace of their course or due dates to support student understanding of a topic.	<i>Total: 14</i> <i>(Female 5, Male: 9)</i> Caleb, Claire, David, Thomas, Hazel, Ryker, Ben, Jane, Nolan, Rose, Cora, Kai, Luke	Understanding. Compassion

***4.3.2.1 Category 4: Professors who prioritize learning over grades through the design of their course materials***

This category describes students' experiences of empathic concern where a professor, through the design of the course and assignments, prioritized students learning the subject matter over grades. Twelve of 27 students identified this type of experience in describing empathic concern expressed by professors, including five female and seven male students. Students felt that in expressing this type of empathic concern, professors placed a greater emphasis on students understanding the material in a course than completing tasks. Caleb, a junior in Mechanical Engineering, described this in his experience of empathic concern:

I think it's really does come down to where their [the professors] priorities are.

You know, the students know if the professor is really genuinely concerned about us learning the material, and I guess it goes back to the empathic behavior if we feel like they really do care about our learning. It comes through in their lessons.

It comes through the homework, and understanding, and even grading, in their office hours, and all of that (Caleb—Male, Mechanical Engineering, Junior—Lines 502–507).

In particular, professors demonstrated this type of empathic concern by narrowing down the material covered in a course, allowing revisions and extra credit on assignments as part of course policies, incorporating excess time on tests, and providing a variety of learning resources. These practices shifted the emphasis from completion of tasks for a grade to a focus on students learning the material. The focus of this category is on the preemptive work that a professor does to prioritize learning and deprioritize grades, or to adjust to assessments based on student performance. This category does not include

student experiences where professors adjusted the schedule of a course or due dates, which are captured in Category 6.

Ben highlights a professor in a sophomore level class who demonstrated this type of empathic concern by providing excess time on a test and being available during the testing time to clarify any student questions. This helped reduce students' stress and allowed them to focus on the content of the assessment. In describing his experience of empathic concern, Ben recalled the professor saying:

I want you to have as much time as you want. We're going to do the test in class so that if I wrote anything poorly, you can raise your hand, you can call me out on it. I can answer that question and help you, which is having 3 hours on a test, that's 45, 50 minutes, it takes so much of the stress off of it (Ben—Male, Mechanical Engineering, Junior—Lines 124–127).

Students also suggested that professors expressed this type of empathic concern by narrowing down the material covered in a course. Students felt that professors who narrowed down the material demonstrated empathic concern as they were more focused on students deeply learning the subject matter instead of cramming as much information into the course as possible. This often came up in non-empathic examples where a student wished that a professor had demonstrated empathic concern. David describes this type of experience in a sophomore level course where there was an overwhelming amount of information on each of the exams:

And so, every exam was same thing, just study as much as you could without really any idea of where to focus your attention on. And so, when you got to the exam, you just hoped and prayed that you had studied the right thing. ....a lot

of us were hoping in that class that he would make it so that we could take the most important parts of it or the most general things about it and be able to learn those so that we felt like we could learn something from class because a lot of the times it felt like we weren't learning but trying to just memorize as much as we could (David—Male, Mechanical Engineering, Senior—Lines 558–568).

Overall, students felt that professors who demonstrated this type of empathic concern showed that they cared more about the class and their understanding of the material than students' specific grades. This led to, students feeling like they could worry less about the grade and focus more on learning the material. In the following examples, Ben highlights a professor of a junior level course who is focused on students learning the material. Similarly, Nolan describes how professors who express this type of empathic concern can support students' focus on learning. He suggests that in courses where students are focused on getting a good grade, they lose sight of what they are supposed to be learning. Finally, Wren highlights that this type empathic concern allowed her to really focus on learning in an introductory first year course, rather than stressing about getting a perfect grade.

And he's really concerned that we understand the material. I don't think he really particularly cares how we do on tests, how we do want homework. He just wants to see that we've understood the material, which I think is the right way to approach it. And so, he totally changed the formatting of the next test so that it was a lot easier for us to, like, dive deep into the material, learn it, comprehend it, and then be able to regurgitate it to what he was questioning (Ben—Male, Mechanical Engineering, Junior—Lines 275–281).

The goal is for you to understand the concepts and know the skills by the time you leave the class regardless of the grade. The grades almost seem tangential to the class. But then there's other classes where, like for example, the class were 50% average on quizzes, the class average is a C. For a bunch of perfectionist engineers, that is very stressful. And because of that, I feel like the focus, at least for us, learning almost gets set aside to focus on getting a grade (Nolan—Male, Electrical Engineering, Junior—Lines 777–785).

I was able to calm down a little bit on worrying so much about what grade I'd get and actually focus on the assignments and learn something from them and not worry about them being perfect and getting a perfect grade. Because that's kind of a hindrance to actually learning (Wren—Female, Computer Science, Senior—Lines 140–144).

These student experiences highlight how this type of empathic concern is expressed and can support a focus on learning in engineering programs. This category of experiences focuses on experiences where a professor places an emphasis on learning material over the grades through the design of their courses and assessments. Students' felt this approach allowed them to focus on understanding the important concepts of the subject rather than just completing assignments.

***4.3.2.2 Category 5: Professors who create a dynamic lecture environment and safe space for asking questions***

This category represents student experiences of empathic concern when a professor created a dynamic and engaging lecture environment in their course. Fourteen of 27 students described this type of experience of empathic concern, including six female students and eight male students. Students described this type of empathic concern in experiences where a professor encouraged open dialogue and responded positively to questions, including answering them without judgement. In addition, students described this type of experience in situations where professors created an engaging environment by introducing relevant examples and demonstrations. Caleb highlights the importance of professors being open to questions, and their positive and non-judgmental response to these questions, in describing an experience of empathic concern in a senior level course

There's a professor that I have that you can just tell every day in class, he's extremely well-prepared. He takes really difficult concepts and he explains them very simply. And then he creates an environment in the classroom where it's okay to ask questions even if it's something that you "should already know." And it just creates a really safe environment to where people feel okay to raise their hand and ask, "I'm so sorry, [professor], but this is a question that I have, and maybe I should know this." And he just has a way of making you feel like, "That wasn't a dumb question. I'm glad that you asked because you're probably not the only student that has that question. I remember what it was like to be in your shoes thinking, Oh my gosh. What is going on in school? And then they kicked me out the door and gave me a degree." And he said, "So, I'm glad you're asking these

questions because I want you to know more than I did when I was in school."

And, like, that's a great example I think of a professor creating an environment where we feel safe and it's because of his empathy towards us as students and understanding the craziness that engineering brings and in trying to learn it (Caleb—Male, Mechanical Engineering, Junior—Lines 82–97).

In contrast to this positive experience, Nolan describes an experience where he wished the professor showed empathic concern. Instead, this professor of a junior level course does not deviate from their lecture notes and does not often take time to answer students' questions.

Let's start with the negative. Like, for example, one of my professors currently, he has a very detailed outlines for what he's going to cover in the class, and he does not deviate from that outline ever. When questions are asked, he generally blows them off and continues on his outline. Like not directly blows them off but it feels like a brush off (Nolan—Male, Electrical Engineering, Junior—Lines 255–259).

Jane highlights a similar example and goes on to explain that professors who are open to questions can help students to see a different perspective.

Those are teachers that they just...they're there to present their material, and you kind of feel like if you raise your hand, you're interrupting them, you know? Or you feel like they have a way they want the lecture to go, and that's the way it's gonna go. Whereas a lot of times I think in classes where teachers are just more open to questions, and really try to encourage them, you know, you might have classes where you actually do go off on a bit of a tangent, or explore another area,

and I think that actually does end up being valuable, too. And just that, you know, it kind of helps you see a different perspective, especially since the homework's gonna make you, you know, already learn whatever thing they had planned for lecture kind of stuff (Jane—Female, Computer Science, Senior—Lines 248–257).

These experiences suggest that an important aspect of demonstrating this form of empathic concern is being flexible and open to answering student questions in a lecture environment. In addition, Rose highlights the importance of professors responding non-judgmentally to students' questions. Her experiences with a professor in a junior level course who responded judgmentally to students' questions eventually led her to stop asking questions in that class.

I did feel he expressed judgement because there were multiple times in class where halfway through the class, I stopped asking questions for, like... At the beginning of the class, when I would ask questions, and he did it with almost anyone who would ask questions, he'd be like, "Well, what do you mean you don't understand?" And, like, word for word, "What do you mean you don't understand?" And there were several times where if multiple people in the classroom would continue asking questions along the same lines, he was like, "This is a very simple concept, people." Like... (Rose—Female, Biological Engineering, Senior—Lines 623–630).

Beyond supporting open dialogue and responding non-judgmentally to students' questions, this category highlights professors who express empathic concern by creating a dynamic lecture environment. This includes integrating examples and demonstrations into their courses. One computer engineering student described how the time flies by

when he is in a sophomore level class with a professor who he felt expressed empathic concern. In this experience, Thomas felt that by bringing in lots of examples and creating an engaging course, the professors demonstrated that they cared about students learning.

But that's like the only class that I've like looked at my watch and then be like, "All right, we're starting class." And then it's ending class. Like it was just like...just really like you learn so much. He has a lot of hands on examples. That's something that is really important that shows that teacher cares is they don't just copy their notes. I mean, if a teacher has their notes up and they're looking at the board and they're writing as fast as they can and all the students are writing as fast as they can, you're not learning (Thomas—Male, Computer Engineering, Senior—Lines 286–293).

Another student, Luke, suggested that professors demonstrate compassion as part of empathic concern when they do demonstrations for a class. In this situation, he felt that empathic concern was represented by the professor of a sophomore level course being willing to put additional time into creating the demonstration, and then as he used it as an in-class tool to support student understanding.

Like, he's up there doing the demonstration for us so that we can remember it. And so, he was very kind of thorough in making sure that we were catching what he was trying to show us. And so, he'd do the demonstration, he'd ask questions, he'd do the demonstration again. And sometimes he'd do it even three or four times, until he felt confident that he could move on to, you know, the next concept in the lecture or the next part in the lecture. [...] I think it shows a concern for the students' understanding of the material. And so, that to me is compassion because

it's showing that he cares about the class, like he cares about the students, and so he's willing to do a demonstration multiple times to help check the class's level of understanding (Luke—Male, Civil Engineering, Junior—Lines 253–265).

Along with providing examples and demonstrations students felt that professors could create a dynamic lecturing environment by knowing students' names, engaging in friendly banter, and sharing personal anecdotes. Students also felt that they had better rapport with professors who were personable and worked to build human connection. David describes this type of environment in highlighting a professor of a junior level course who he felt demonstrated empathic concern:

So, in the classroom environment, this professor is very just open. There is a certain amount of banter and teasing that goes on between her and the students, just them making jokes or, yeah, just... I don't know. There is a friendly environment in the classroom, though, because this professor is very open to speaking and she's very strict on how she teaches or more so on how she grades. She is a very hard grader, but she is also very willing to just talk and answer questions (David— Male, Mechanical Engineering, Senior—Lines 272–281).

Overall, students in this study felt that experiences with this type of empathic concern supported their learning as it helped them build a connection with the professor and feel more comfortable asking questions in class. Hazel highlights this in describing their experiences of empathic concern:

I think when they have empathy, it opens up more doors for my learning because they have a lot of knowledge that I don't have. And the more comfortable I am talking to them, the more I feel like they understand me, I guess, the more I can

go and learn from them even outside of the classroom, or even in the classroom with the stuff they're teaching, I'm more comfortable raising my hand and asking a question in class (Hazel—Female, Biological Engineering, Senior—Lines 635–640).

This category encompasses students' experiences of empathic concern where a professor created an engaging and dynamic lecture environment through examples and demonstrations. Additionally, this category captures student experiences of empathic concern where professors encourage open dialogue and created a safe space for students to ask questions. Students suggest that these experiences of empathic concern support their learning as they encourage connection between professors and students and make students feel comfortable asking questions in class.

#### ***4.3.2.3 Category 6: Professors who adjust the pace of their course based on student needs***

This category includes student experiences of empathic concern where a professor gathers feedback from students and adjusts the pace of their course, including assignment due dates, to support student learning. Fourteen of 27 students described experiences of empathic concern in this category, including six female and eight male students. Students described this type of empathic concern in situations where the professor gathered input from students, or checked for understanding, and was flexible in adjusting aspects of the course. This could include taking the time to recover material that students did not understand or adjusting due dates, giving students more time to learn the material. The focus of this category is on understanding students' needs and making a change in the course to meet this need.

In the first quote Claire highlights a professor's flexibility and willingness to extend a due date as part of her definition of empathic concern. In the second quote, another student, Rose, describes how a professor in a senior level course will take the time to gauge where students are at and adjust assignment due dates based on their feedback. Both students felt that professors who expressed this type of empathic concern were more focused on students' understanding than the specific assignment due dates.

Empathic concern for me looks like regardless of the rules and the regulations and the schedule that they have in place, it's being flexible, really, I guess. Being flexible with their schedule. Saying like, "Okay, I am willing to extend the due date or I am willing to make an exception or whatever it may be. Because you learning the material is more important to me than meeting the deadlines"

(Claire—Female, Computer Science, Senior—Lines 683–688).

And he'll sit there, and he'll answer questions and gauge how we're doing. And so, he'll move the deadline of...so the due date of the assignment based off of how he feels we're doing as a class and whether or not he feels we're grasping the material. Even if we've turned it in. If he doesn't feel we've grasped the material, then he'll push back the due date of the assignment. And we'll spend another day in class going over just the fundamentals of what we were supposed to learn during that assignment. So, I feel like he does a really good job of gauging where we're at as students (Rose—Female, Biological Engineering, Senior—Lines 73–88).

In addition to being flexible with assignment due dates, students described a professor being willing slow down the pace of the course and recover material that students are not understanding as an expression of empathic concern. Rose highlights this briefly in her statements above, and Ryker described a similar experience where a professor of a junior level course planned another lesson on a topic students' were struggling with:

And the fact that he decided to plan another lesson around our project without even asking us if we wanted another lesson on the project shows that he knew what we were struggling with, like the specific points, and he went through and covered them again. And I don't know how he knew, but he knew what we were struggling with (Ryker—Male, Electrical Engineering, Junior—Lines 256 – 261).

One student emphasized that professors could plan for flexibility in their schedule at the start of the semester. He felt that including flexible days in their syllabus demonstrated that professors care more about learning than just getting through the semester.

Yeah. So just, a lot of times, they'll have kind of a schedule of what sections they wanna go over every day, and then, at the end, there will just be blank days that don't have a lesson plan, basically. So, if we end up taking more time or we need more explanations, you know, sometimes that happens when there's a lot of questions being asked, so it kinda slows down the pace of the lectures. We need to kind of extend it, and, usually, it kinda just pushes back the calendar into those extra days.[...] I guess it shows that they're willing to, you know, take the time to explain things throughout the semester more if people aren't understanding it, like, rather than being set in a really hard schedule that, "Oh, if you don't get it, I guess,

well, you just not have to get it and we'll just keep going," you know? So, I think it kinda shows that they care more about our learning rather than just getting through the semester (Kai—Male, Mechanical Engineering, Senior—Lines 298–303).

Students felt that professors who were flexible with the pace of their courses expressed this type of empathic concern and placed a focus on student learning. This category captures students' experiences of empathic concern where a professor gathered feedback from students and adjusted the pace of their course; this included pushing back assignment due dates or spending additional time covering materials to support student learning.

#### **4.3.3 Theme 3: Acknowledging the Challenges of Engineering Education**

The third theme of empathic concern in engineering programs depicts student experiences where a professor recognizes the challenges of engineering education and strives to support students by acknowledging these challenges. This theme encompasses two categories describing student experiences of empathic concern in engineering, including professors who convey the difficulty of learning complex engineering topics, and professors who acknowledge the culture of engineering programs. One student suggests that professors who are able to understand the stressors of engineering programs can help to challenge the stereotype of STEM fields:

And I think having professors reaching out and to helping us because they're obviously more experienced in the field [...], and they have more life experience. They know what we're going through because they had to get a degree, too, and I

bet it sucked just as much if not worse. And so, I think more empathic concern would be appreciated to relieve sort of the stereotype that STEM majors and engineering professors are cold people who hate others and don't understand feelings and just to give the students a support system in a really, really tough environment (Ryker—Male, Electrical Engineering, Junior—Lines 726–737).

Another student suggests that this form of empathic concern is necessary in supporting the development of ethical engineers.

I mean, people are human. I mean, if like...we're not robots. I mean, how are you supposed to teach people to be like these ethical, upstanding engineers and, you know...if you don't...if you just treat them like robots like pumping them through a factory? That doesn't make sense at all. It's like you wonder why the world is the way it is, like why engineers turn out the way they are. A lot of the times it's the product of the education that they've had and the professors they've had that have shaped them. And that happens...I mean, that's what college is, a big vat of everyone put together and, you know, you're spitting out degrees. At least that's how it seems a lot of the time (Thomas—Male, Computer Engineering, Senior—Lines 779–787).

This third theme encompasses two categories of experiences described by students, including professors who convey the challenges of learning engineering concepts, and professors who recognize the culture of engineering programs. The details of these categories are provided in Table 7. This theme highlights the particular need for empathic concern in engineering programs as students struggle with the rigorous academic demands and challenging topics. However, these experiences were the least

prominent in students' descriptions, suggesting that these expressions of empathic concern are still emerging in engineering programs.

**Table 7:**

*Theme 3 - Categories of Description (7,8)*

Category	Professors Who:	Description	Participants	Components of Empathic Concern
Category 7	Convey the challenge of learning engineering concepts	This is demonstrated by professors who remember what it was like to learn engineering concepts for the first time and understand the difficulty of learning these complex concepts. In addition, these professors support student success in engineering by emphasizing fundamental concepts.	<i>Total: 8</i> <i>(Female: 4 Male: 4)</i> Caleb, Alice, Cora, Noah, Lily, Charlie, Luke, Mae	Non-Judgement, Understanding
Category 8	Recognize the culture of engineering programs	This is demonstrated by professors who recognize the culture of engineering including emphasis on rigor and meritocracy.	<i>Total: 5</i> <i>(Female: 0 Male :5)</i> Ben, Xavier, Henry, Noah, Kai	Non-Judgement, Compassion

#### ***4.3.3.1 Category 7: Professors who convey the challenges of learning engineering concepts***

This category of empathic concern expressed by professors in engineering includes students' experiences where a professor conveyed the challenges of learning engineering concepts and supported student success by focusing on mastery of

fundamental concepts. Eight of the 27 students described experiences in this category, including four female and four male students. Students described this category of empathic concern in experiences where professors recognized, and conveyed, the difficulty of learning complex engineering topics for the first time. Alice emphasized the importance of this in describing her experiences of empathic concern in engineering programs:

So acknowledging that this is a hard concept, it's a hard class and it's completely understandable that you're not getting it right away was just a relief, because some professors, they've been doing it for like 30 years and they forget that we are learning it for the first time. So, it's not easy (Alice—Female, Mechanical Engineering, Senior—Lines 167–170).

Another student described a similar experience where a professor acknowledged the difficulty of the material and provided additional resources to support students:

So, I'm thinking about some of my classes in the engineering building [...] where all the students were brand, brand, brand new to the subject, like this is not a class you take in high school. And I remember the professor saying things all of the time like, "Remember, if you're not understanding, here's some extra tools for you." Always posting like Khan Academy videos on Canvas like, "If you're not understanding, here's more ways for you to understand because this is really tough." And acknowledging that the subject matter was super new, and some students weren't gonna get it as quickly as others, giving those students an opportunity to succeed (Lily—Female, Civil Engineering, Junior—Lines 471–484).

Additionally, a few students described this type of empathic concern as professors who emphasize the importance of learning fundamental concepts. They emphasized that students would need to understand these concepts in order to be successful in future courses. Alice describes an experience where a professor of a sophomore level course required retakes on an exam for students who scored below a certain grade. In this experience of empathic concern, she felt that the professor supported her success by making sure she had mastered the fundamental concepts. By giving students a chance to retake the test, the professor acknowledged that learning these concepts could be challenging for students.

Because I think acknowledging that this first exam, if you don't understand this material, you're really going to struggle with the rest of the material, because this is the absolute basics of it and everything else will build off this. So, if you don't understand it, you might not understand it later on when it gets more complicated. And giving people the opportunity to show that they have studied again and they're actively trying to understand it outside that first exam was really nice. It was just expressing the like, "I believe you can do this, and I want you to show me you can do this because it's going to be harder later." And then acknowledging that, "It's hard now, it's going to be hard later and that sucks. That's just how the class is. I need you to understand it now so that later it's not as terrible" (Alice—Female, Mechanical Engineering, Senior—Lines 384–394).

Students who described experiences in this category felt that professors who expressed empathic concern in this way supported students who were struggling by

explicitly recognizing that it is okay to struggle with learning new material. Mae describes this type of experience below:

An empathic professor [...] allows you to know that struggling is okay. Because a lot of the time, I think you look at someone else and they're thriving and you're struggling and you wonder like, "I shouldn't be struggling. I should understand this. I should know how to accomplish this." And you beat yourself down for it. But knowing that it's okay to struggle and the professor is right there to help when you need it can really lift your...just lift how you're feeling about yourself and be able to help you get through those classes even though they could be the most challenging class of your life to know that you have the power to get through it and it's okay to ask for help (Mae—Female, Civil Engineering, Senior—Lines 363–372).

This category captures students' experiences of empathic concern where a professor is able to remember what it is like to be an engineering student learning these topics for the first time. This allows them to explicitly acknowledge the challenges of learning complex engineering concepts and support students' success in engineering programs.

#### ***4.3.3.2 Category 8: Professors who recognize the culture of engineering programs***

This category describes students' experiences where they felt that professors understood the culture of engineering programs and demonstrated empathic concern by trying to reduce the stressors of these programs. Five of 27 students described this experience, all of whom are male. The low numbers of students who described this this

category suggest that this experience of empathic concern is still emerging in engineering.

One student compared a professor who recognized the culture of engineering programs and expressed empathic concern with a professor who did not show empathy:

So, when the professor who cares, they're showing empathy because they're like, "Hey, I've been in your shoes. I've done the all-nighters. I've done the weekend study sessions. I've done all that stuff. I'm going to try and make your life a little bit easier. And, hopefully, you'll enjoy the material. Hopefully, you'll like learn it, understand it." The other professors, the bad professors, even though they've done all that stuff, they just don't care. They're just kind of like, "Yeah, you're in my class, I expect you to do everything that I ask you to do. And I don't care that you're taking four other classes and have a part time job, or taking three other classes, a full-time job. I don't care if you're married, you have three kids. This is what I expect from you. I'm going to be really rigid with it" (Ben—Male, Mechanical Engineering, Junior—Lines 607–616).

Several students described experiences where a professor recognized how stressful engineering programs are and offered students a reprieve from this stress. In some of the experiences in this category students described, the professor was aware of the coursework and workload in other classes and made adjustments to their course to accommodate this.

I think professors more times than not realize that some of the things required in the homework and the test and that other homework, there were three things due that he probably realized that it was too much due. And then I've had professors

even comment in class, they say, "I noticed that you have a lot of other stuff from these other classes, and so to make it a little bit easier on you all change my standard." I'm imagining that's what happened, is the professor noticed that the students were stressed and not up to date with all of his assignments. And so, he changed it (Henry—Male, Mechanical Engineering, Senior—Lines 108–115).

Another student described an experience with a computer science professor who worked to explicitly reduce engineering students' stress:

Just recently in my computer science class, our professor was talking about, you know, how people have come into him saying that, you know, they're really stressed and they don't think that they can, like, complete an assignment for his class or something. And he was basically saying that if at any point any of his students feel really stressed out by anything, whether it's just a bunch of stuff or his class in particular, that he doesn't want to, you know, be part of the reason why that's happening. So, basically, just open invitation that if that happened to come talk to him and that he would be happy to work out a solution where, you know, it leaves the stress wall, so still being able to complete an assignment and use that, you know, as a learning opportunity still (Kai—Male, Mechanical Engineering, Senior—Lines 184–193).

By recognizing the other obligations that students have on their plate, and reducing students loads, professors acknowledge the culture of engineering programs and strive to better support students. This category highlights student experiences where a professor explicitly recognizes the intensive culture of engineering programs and strives to reduce the stress of students who are in them.

## CHAPTER V

### DISCUSSION

This study explores the use of empathic concern by professors in engineering programs under the premise that this approach may help to improve the educational experiences of undergraduate engineering students. Using rich qualitative data gathered through semi-structured interviews, student perspectives on the components of empathic concern and the distinct experiences of this phenomenon in engineering programs were explored. This chapter discusses the results of the study in relation to the current literature on empathic concern in education and the two guiding research questions. Recommendations for further implementing empathic concern as a teaching practice in engineering programs are provided. Finally, limitations of this study and future work relating to this phenomenon are discussed.

All of the students who participated in this study portrayed positive experiences of empathic concern and felt that professors who implemented this as part of their teaching practice contributed to the success of undergraduate students in engineering. One student highlighted the importance of empathic concern in engineering courses by saying that “having even one professor who genuinely cares is enough to keep you trudging through the mud and the slop that is engineering undergrad” (Ben—Male, Mechanical Engineering, Junior—Lines 657–663). The experiences described by students suggest that empathic concern is present in engineering programs and can play an important role in supporting the learning, retention, and motivation of engineering students. This aligns with the research by Micari and Pazos (2016) and Vogt (2008), which suggests that reducing faculty-student distance and increasing rapport between professors and students

can have a positive impact on students' performance and retention in engineering programs.

The evidence of empathic concern as part of the teaching practice of professors suggests a positive shift toward creating more supportive cultures in engineering programs. However, it is important to note that while students portrayed positive examples of empathic concern, they also described non-empathic experiences. In these examples, student depicted instances where they wished professors had prioritized the learning and success of students. The lack of empathic concern demonstrated by professors in these experiences challenged student's persistence in their engineering education and deterred their interest in specific careers or subjects. This finding aligns with the research by Jensen and Deemer (2019), which found that the chilly climate of STEM fields can lead to lower self-efficacy and academic burnout.

It is important to acknowledge how the culture of engineering may challenge the introduction of empathic concern in engineering programs. Cech (2014) describes three pillars which characterize the culture of engineering programs including depoliticization, which reduces the focus on public welfare; technical/social dualism, which devalues social competency; and meritocratic ideologies, which suggest social structures are fair and just. This places pressure on faculty to demonstrate their technical proficiency and introduce rigor into their coursework, which may be counter to the culture created by expressing empathic concern (Christie, 2013). However, the results of this study suggest students are eager for this culture to change and appreciate the support of professors who express empathic concern.

Several students suggested that professors may also struggle to express empathic concern be due to the conflicting demands of research and teaching on a professor's time. Christie (2013) and Vogt (2008) suggest that this conflict is perpetuated by the culture of STEM education and the promotion and tenure system that rewards technical knowledge and research over teaching. Early-career faculty in engineering programs may struggle with the multitude of demands on their time, especially as they work towards tenure (Maranto & Griffin, 2011). To address this, Christie (2013) suggests there is need to address the "long-standing conflict between institutional goals of research and teaching that may contribute to diminished student-teacher relationships in STEM disciplines" (p.24). Further, Vogt (2008) highlights that to support this shift, changes to the traditional tenure and promotion process, which promotes research and can often devalue teaching, will be needed. These results of this research suggest that implementing expressions of empathic concern can support the educational experiences of undergraduate engineering students. However, it is important to recognize that there are several challenges that professors wishing to integrate empathic concern into their teaching may face.

Additionally, the contrasting experiences of empathic concern and non-empathic concern in a student's engineering programs suggest that there is lack of consistency in the application of this teaching practice. The impact of students' non-empathic experiences suggests there is a continued need to increase awareness of the importance professor-student relationships and to explicitly outline the action or behaviors that can support expressions of empathic concern in engineering programs. While faculty can play an important role in improving the academic climate in engineering programs by establishing rapport with students, larger scale systematic changes are needed to fully

support the integration of empathic concern into the culture of engineering programs.

Though professors in engineering programs may face resistance to implementing empathic concern as part of their teaching practices, this approach may serve as an important first step towards warming the academic climate engineering programs.

Students suggested that even small changes that show a professor is trying to care (even if they don't always get it right) can have a favorable impact on students. This echoes research in the broader field of education that suggests that care and rapport building is an important dimension of instruction in higher education which supports learning (S. A. Meyers, 2009). Additionally, research by Teven and McCroskey (1997) suggests there is a high correlation between professors who are perceived as caring and positive course evaluations.

While the benefits of relationship building have been recognized in the broader context of education, Christie (2013) suggests there is a continued need to challenge the culture of STEM education and that "institutions seeking to increase their STEM retention and graduation rates may need to promote improved awareness of the role of professors-student relationships" (p. 24). By further incorporating experiences described by students as part of this research study, professors have the opportunity integrate empathic concern as part of their teaching practice and improve rapport with their engineering students. The following sections discuss how the components and specific expression of empathic concern are currently implemented within the context of engineering programs.

### **5.1. Implementing Components of Empathic Concern in Engineering Programs**

The first research question of this study investigates how engineering students described the components of empathic concern, including understanding, non-judgement, and compassion, in their experiences with engineering professors. Analysis of interviews with students in undergraduate computer science and engineering majors suggests that all three components of empathic concern necessary for building helping relationships are demonstrated by engineering professors. Rogers (1961) suggests that each of these components of empathic concern are critical to establishing helping relationships and creating student-centered environments which support learning.

Students descriptions of these experiences highlighted the key components of empathic concern which students perceive contribute to professor's expressions of empathic concern. Out of the seventeen experiences described by students, three are supported by the key component of non-judgment, seven are supported by the key component of understanding, and seven are supported by the key component of compassion. This indicates that the components of compassion and understanding are more widely represented in experiences of empathic concern than the component of non-judgement. This reflects more common conceptions of empathy which center on being able to understand another's situation and feelings (understanding) and expressing care or concern (compassion) for another's situation (Baston, 2011; Reynolds & Scott, 1999). The limited representation of non-judgement in students' experiences highlights a need to draw more attention to this component of empathic concern. Each of the components of empathic concern which support the development of helping relationships are further discussed in the following sub-sections.

### 5.1.1 Understanding

In recounting their experience of empathic concern, students described understanding as the component which allows professors to “step into the shoes” of their students and remember the challenges of being an engineering student. Specifically, professors demonstrated this component of empathic concern by recognizing students have a life outside of their engineering courses and making accommodations for individual students’ situations. Additionally, students felt that professors demonstrated understanding by gathering feedback and input to understand the needs of their classes. Finally, students suggested understanding was part of their experiences of empathic concern when a professor acknowledged the difficulty of learning complex engineering concepts.

These experiences of understanding align with the conceptual framework of components of empathic concern necessary for establishing helping relationships described by Rogers (1975). This framework suggests that the component understanding allows a teacher to step into the world of students to better understand their thoughts or feelings as they grapple with academic demands and new subject matter (Rogers, 1961). This ability to understand others can help you “see aspects of the situation you may not have noticed and leads to better results in interactions and negotiations” (Goleman et al., 2017, p. 22). Cooper and Miness (2014) suggest that faculty must engage in both academic and personal understanding of students. *Academic understanding* allows educators to identify gaps in knowledge and misconceptions of students and allows faculty to better support students’ learning. While *personal understanding* allows educators to understand individual students’ backgrounds and situations that allows them

to support students' general well-being and overall development as people. Both of these forms of understanding were highlighted by students in this study as part of their descriptions of engineering professors' expressions of understanding. Students felt that professors who took the time to understand their individual situations demonstrated personal understanding, while professors who took the time to gather feedback and input from their classes demonstrated academic understanding.

In addition, Cooper and Miness (2014) suggest the component of understanding is particularly crucial in establishing relationships between underrepresented students and white faculty members. Specifically, in engineering education, Long and Mejia (2016) emphasize the importance of conversations that can support a professors' understanding of underrepresented students' experiences:

Most importantly, faculty and staff must actively engage in conversations with diverse students to learn more about how to provide the adequate support they need. Conversations between educators and diverse students should focus on current and past events – ones involving educational barriers underrepresented students have faced or overcome in addition to how they have shaped society. Such conversations with students can provide us with the opportunity to have an open dialogue about educational equity as well as an evolving society and democracy (p. 215).

Engaging in these types of conversations can support professors' understanding of students' backgrounds and situations, which in turn allows them to better recognize the needs and best ways to support their students. In building these relationships, professors gain a deeper understanding of their students, which can support the creation of more

inclusive environments that will allow students to bring their whole selves to their work while feeling welcomed and valued (Long & Mejia, 2016; Puritty et al., 2017).

### 5.1.2 Non-Judgement

Students described the component of non-judgement as an important component in three of their experiences of empathic concern. These experiences of empathic concern align with the conceptual framework which suggests that non-judgement allows individuals to set aside their own perceptions and biases in order to acknowledge and validate the feelings of another (Rogers, 1975). Specifically, students felt that non-judgement in empathic concern enables professors to support students by acknowledging and validating their questions in a lecture environment and responding positively to their emotions. This reflects Goleman et al. (2017) description of non-judgment that suggest this component of empathic concern is an important part of listening as it enables the listener to acknowledge and validate an individual's feelings in a supportive way.

Within a whole class setting, students felt professors responding without judgement supported a safe space for asking questions. This suggests that non-judgement can support *psychological safety*, which is defined as a shared belief that an environment is safe for interpersonal risk taking (Edmondson, 1999). This construct has been found to be a critical component of effective teamwork and can support an individual's human development as well (Edmondson & Lei, 2014; Wanless, 2016). In a whole group setting, psychological safety, supports questions asking, introduction of innovative ideas, or reporting mistakes (Edmondson, 2004). Within an education setting this can help create a safe and supportive environment for students (McAllister & Irvine, 2002). This suggests

that professors who express non-judgment as part of empathic concern can create a safe psychological space for students to ask questions and deepen their understanding of the subject matter.

In one-on-one settings, students felt that professors expressed empathic concern when they responded non-judgmentally to emotional students. In these situations, professors took the time to acknowledge and validate students' feeling and concerns. This aligns with Rogers (1957) description of non-judgement as "unconditional positive regard", which he suggests is a critical condition of establishing helping relationships. Further, Puritty et al. (2017) suggest that non-judgement is necessary to support inclusion in STEM by allowing students and researchers to bring their whole selves to their work. By responding non-judgmentally to students, professors can display empathic concern, which encourages students to be authentic and communicate areas where they may need support.

Students described the component of non-judgement as the key component in supporting three of their seventeen experiences of empathic concern. This suggests that non-judgement was the least prevalent component recognized by students in professor's expression of empathic concern. Wiseman suggest that this component of empathy must be supported by self-awareness, which is considered an antecedent to expressions of empathic concern (Wiseman, 1996). This implies that professors may need to place greater emphasis on understanding how their positionality and biases contribute to their interpretations of students' situations. Responding non-judgmentally to students who need emotional support, can assist professors in displaying empathic concern which encourages the development of positive relationships. Additionally, in demonstrating

empathic concern towards a whole class, expressing non-judgement enables a professor to create dynamic and engaging lecture environment and a safe space for student to ask questions.

### **5.1.3 Compassion**

Students identified compassion as an important component in their experiences of empathic concern expressed by professors in engineering. In describing their experiences students often translated the idea of empathic concern to expressions of care. This interpretation aligns with engineering faculty's perceptions of the difference between empathy and care explored by Strobel et al. (2013). This study found that faculty perceive empathy to be a more passive action of understanding another's perspectives or feelings while caring was interpreted as a more active process. Therefore, students' interpretations of empathic concern as an active process of caring aligns with faculty's interpretation of care as actively engaging in the process of helping others. The varying definitions of empathy, empathic concern, and care suggests a need to further clarify how compassion is enacted in engineering programs.

Students felt that this component of empathic concern was present in experiences where professors demonstrated care for students as individuals or when they prioritized helping students. In expressing empathic concern towards the whole class, students felt that professors demonstrated compassion by placing an emphasis on learning the subject matter versus grading students. Additionally, students felt that a professor expressed compassion when they took the time to express care for individual students by caring about their individual situations and wellbeing.

These findings reflect the expression of care in engineering teaching recently identified by Baier et al. (2020). In this preliminary work-in-progress paper, the researchers used a grounded theory approach to explore engineering faculty's practices and attitudes towards care in engineering teaching. In describing care in their teaching, faculty focused on two dimensions, *person-oriented care*, which allows them to build relationships and show genuine concern for students as individuals and *student-oriented care* which facilitates care in the design and execution of their courses (Baier et al., 2020). Another study in engineering education by Hong and Shull (2010) explored the role of faculty dispositions on undergraduate students in engineering and highlights the importance of expressing care for individuals as well as whole groups. The finding of this study supports the positive outcomes of expressing care towards students as individuals' and concern for the success courses.

Within the broader application of higher-education, care is recognized as central to the practice of teaching and learning (McBee, 2007; S. A. Meyers, 2009). Prior research on student-faculty interactions suggests that students appreciate feeling cared about, so much so that appreciation for expressions of caring were commonly expressed in thank you notes to instructors (Grantham et al., 2015). This practice is becoming increasingly recognized as an important component of the teaching practice of engineering faculty (Baier et al., 2020; Christe, 2013; Vogt, 2008). Wankat and Bullard (2016), suggest, "no matter what your teaching style may be—flashy or congenial or scholarly—if students believe you care about them, most will be motivated to learn what you are teaching. If you convey a sense of not caring, then no matter how brilliantly or entertainingly you lecture, far fewer will be so motivated" (p. 16). As this practice is

increasingly recognized as an important component of teaching, there remains a need to identify the specific actions or behaviors which professors can use to express care in the context of engineering programs. Expressions of empathic concern within the context of engineering programs are highlighted as part in the following section

## **5.2. Expressing Empathic Concern in Engineering Programs**

The second research question of this study explored students' perceptions of the qualitatively different ways engineering professors expressed empathic concern. Understanding the variation of experiences associated with this phenomenon supports a deeper understanding of how empathic concern is currently expressed in engineering programs. Phenomenographic analysis of student experiences of empathic concern identified eight different ways professors expressed empathic concern in engineering programs. These experiences range from professors who are eager to help individual students, to professors who adjust the pace of their courses to support students learning, or professors who recognize the culture of engineering programs. As part of the analysis, the relationships between students' experiences was explored and eight distinct experiences were grouped under three overarching themes that describe the objectives of the expressions of empathic concern. These themes include: (1) expressing care for students as individuals; (2) cultivating student learning; and (3) acknowledging the challenges of engineering education; each of which are discussed in further detail in the following sections.

### 5.2.1 Expressing Care for Students as Individuals

In describing their experiences of empathic concern expressed by engineering professors students' emphasized the importance of feeling cared for as a student and an individual. Three of the eight categories of experiences related to this overarching theme including:

- Category 1: Professors who understand students' individual situations and make accommodations
- Category 2: Professors who commit to helping students succeed
- Category 3: Professors who care about student's well-being and respond non-judgmentally to emotion

These categories highlight the importance of professors who build relationships with students by taking the time to address their individual situations, academic needs, or emotional support.

Students felt that professors who took the time to understand their individual situations including family obligations, travel, or illness, and make accommodations better supported their motivation to learn the material. This was particularly important for non-traditional students who are returning to school and often juggle work or family obligations outside of their education. Within engineering, a study by Hong and Shull (2010) found that students appreciated the time professors took to get to know them and learn about their interest, career goals, problems, and struggles. Meyers et al. (2019) emphasizes that the standards for assignments should not be lowered, but rather that accommodations that support a student's learning from assignments should be considered.

Students also felt that professors demonstrated empathic concern by making themselves available and being eager to help students. Students recognized this expression of empathic concern when professors had open door policies, showed up outside of their office hours to help students or by encouraging students to seek individual help during lectures. These experiences suggest that students can tell when a professor is eager to help students, or when they prioritize other obligations such as research. A study of teacher perspectives on caring identified “offering to help students” as the top characteristic of caring teachers. More than a third of the participants in this study also identified “listening to students” and “giving time” as characteristics of caring teachers (McBee, 2007). In engineering education Daly et al. (2012), suggest that professors who have an approachable and caring demeanor and open door policy can have a positive impact on students success. This suggests that professors in engineering can express empathic concern by having an open-door policy, encouraging students to seek help, and giving students their full attention when answering questions.

Finally, students suggested that professors can demonstrate empathic concern for students by caring about their overall well-being and responding non-judgmentally to their emotions. It is important to note that this category of experiences was especially important to women in engineering programs. Many of these students described times when they had cried in front of a professor and appreciated professors who understood how to handle these emotions. A literature review of 18 studies which identified practices to support the success of undergraduate women in engineering suggests that creating an atmosphere where women students feel like faculty care about them is essential to supporting women in engineering (Waychal & Henderson, 2018). S. Meyers et al., (2019)

suggest that affective empathy allows an individual to understand another's emotions or feelings and to support expression of empathic concern in teaching. The importance of experiences described in this study highlights a need for empathic concern in building rapport with individual students, especially in supporting underrepresented students in engineering programs.

Each of the three categories of experiences encompassed by this overarching theme highlight the importance of building rapport and expressing care for students as individuals. This connectedness, which aligns with the principals of mentoring, has been shown to improve student outcomes in difficult courses and create more welcoming environments in engineering education (Marshall & Marshall, 2005; Micari & Pazos, 2012). Prior work in engineering education suggest that mentoring programs can play an important part in building connectedness between professors and students (Chen et al., 2008; Vogt, 2008). Further research on the science of effective mentorships suggest that these relationships can be used to support the development of diversity in STEM professions and develop inclusive cultures (National Academies of Sciences Engineering and Medicine, 2019). Professors in engineering can express empathic concern and build relationships by making changes to increase connectedness with students including taking the time to listen to individual students' situations and making accommodations, being accessible to help individual students and responding supportively to students' emotions and feelings.

### **5.2.2 Cultivating Student Learning**

As part of this research, students highlighted experiences of empathic concern where they felt that professors focused on cultivating student learning as part of the

coursework, pace of their course, and lecture environment. Students described three categories of experiences of empathic concern relating to this overarching theme:

- Category 3 – Professors who prioritize learning over grades through the design of their course material
- Category 4 – Professors who create a dynamic lecture environment and a safe space for asking questions
- Category 5 – Professors who adjust the pace of their course based on students' needs

In each of these experiences, students felt that professors prioritized students learning the subject matter over the completion of task for grades. This approach aligns with a shift from teacher-centered to student-centered learning that emphasizes engaging students in the active process of their own learning rather than the delivery of information from an instructor. Research suggests that student-centered learning environments can support increases in student understanding and retention of materials as well as success in courses (Benson, Orr, Biggers, et al., 2010). However, in promoting a more student centered learning environment Catalano and Catalano (1997) suggest that professors will face three challenges including: (1) resistance from students who prefer to be more passive in classroom environments; (2) questions of rigor in shifting from a traditional teaching-centered environment; and (3) resistance from ourselves to relinquishing authoritarian control in the classroom. To overcome these challenges, professors may need to reflect on their own perception of rigor and control in learning environments. However, the positive outcomes associated with student-centered learning suggest the importance of professors recognizing and addressing the challenges of implementing this approach in

their courses. Students felt that professors who promoted student-centered learning expressed empathic concern by focusing on cultivating student learning.

Specifically, students also felt that professors expressed empathic concern for students by prioritizing learning in the design of their courses and assessments. Research by Chen et al. (2008) suggests that faculty can support student engagement by attending to the design of their courses and educational environments. Students felt that professors who took the time to narrow down material essential to a course, create effective assessments, and provide additional resources for learning supported this type of empathic concern. These strategies reflect the suggestion for improving a classroom environments described by Finelli et al.(2001) who suggest professors should “establish a clear set of instructional objects, develop a syllabus and establish grading policies which are conducive to student learning” (p. 491). This suggests professors should take the time to re-examine instructional materials and assessments to ensure they support learning outcomes. Additionally, Marshall and Marshall (2005) suggest that professors can support students by respecting diverse ways of learning and providing a broad range of materials or modes for students to learn from. Work by Minichiello et al.(2018) suggests that application of user experience design principles can also promote the design of effective educational experiences. Students felt that professors who preemptively put thought into the design of their course materials displayed empathic concern and focused on cultivating learning in their courses.

Students also felt that professors expressed empathic concern by creating a dynamic and engaging lecture environment that supports a safe space for asking questions. Professors demonstrated this by acknowledging and validating students’

questions and engaging in demonstrations and examples. These practices reflect the suggestions for increasing verbal and physical immediacy in a college classroom environment described by S.A. Meyers (2009). *Immediacy* refers to communication tactics that increase connection between professors and students include several of the examples for creating a dynamic and engaging lecture environment. These include addressing students by name, asking questions or encouraging students to talk, moving around the room while teaching and smiling at individual students in the class (S.A. Meyers, 2009). Research in engineering education found that professors who praised students for good comments and answers, promoted student involvement, encouraged question and used everyday examples to explain engineering concepts supports students success (Daly et al., 2012). Additionally, work by Bjorklund et al. (2004) found that professors who demonstrate (through verbal and non-verbal communication) open and respectful attitudes, increased faculty-student interactions, leading to student gains in problem solving and collaborative skills, occupational awareness, and engineering competency. These suggestions highlight ways professors can express empathic concern and increase rapport with students even in larger lecture environments.

Finally, students felt that professors who were willing to adjust the pace of their course based on feedback or input from students demonstrated empathic concern by cultivating students learning. Students felt flexibility in a professor's schedule allowed them to support student learning by recovering materials or extending due dates for the whole class. Akili (2012) describes this practice as responsive teaching, which allows a professors to engage in "regular discussion with students concerning how aspects of the education process might be altered to make them more meaningful" (p. 8). Finelli et al.,

(2001) echoes this suggestion that professors should assess the progress of the course throughout the semester to improve the classroom environment. Further S. Meyers, et al. (2019), suggest that professors can support empathic concern within a classroom by “building flexibility into due dates and explaining the rationale behind policies which can communicate to students that the instructor is aware of the challenges students face” (p. 3). Akili (2012) also suggests that flexibility in professors’ teaching allows them to be more responsive to the peaks and valleys of stress which occur for students throughout the semester. Students highlighted the importance of this flexibility and suggested that if professors are aware of these stresses and can change deadlines that conflict with high stress times in other courses, they can pay more attention to learning the material.

Contrary to other teaching strategies, this practice is not widely recognized as part of engineering education literature and may oppose the perceived rigor and traditionally intensive pace of engineering courses. However, this flexibility was emphasized by many students as an expression of empathic concern which supported a deeper understanding and retention of material in a course. By shifting the focus of their courses to cultivate student learning and being flexible with the pace of their courses to meet students’ needs, professors in engineering can contribute to addressing the academic culture, which is a leading factor in engineering student attrition (Geisinger & Raman, 2013).

### **5.2.3 Acknowledging the Challenges of Engineering Programs**

In discussing their experiences of empathic concern in engineering programs students illustrated examples where professors acknowledged the challenges of engineering programs including conveying the challenges of learning complex

engineering topics and recognizing the culture of engineering programs. Two of the eight categories of experiences described by students are encompassed in this overarching theme:

- Category 7 - Professors who convey the challenge of learning engineering concepts
- Category 8 – Professors who recognize the culture of engineering programs

These categories highlight two emerging forms of expressions of empathic concern in engineering. In both categories' professors, sought to make implicit challenges in engineering more explicit. Specifically, students felt that professors in engineering expressed empathic concern when they were able step into students' shoes and remember what it was like to learn complex technical topics for the first time. By explicitly recognizing that it was okay to struggle with learning these topics, professors were able to better support students' self-efficacy and self-confidence, and support their retention in engineering (Geisinger & Raman, 2013). Additionally, students felt professors expressed this form of empathic concern when they placed an emphasis on students learning fundamental concepts that would be needed for their future success. Acknowledging the importance of these fundamental concepts suggest that professors who express this form of empathic concern have a deeper understanding of the gaps in knowledge or misconceptions which will be common for students.

Along with recognizing the challenges of learning engineering concepts, students felt that professors expressed this type of empathic concern when they explicitly recognized the culture of engineering programs. The “chilly climate” and “tough as nails

culture” of engineering has been well documented (Christe, 2013), which suggest a need to explicitly acknowledge the challenges of this culture. In a literature review of fifty studies relating to undergraduate engineering student attrition and retention, Geisinger and Raman (2013) found that 11 studies identified individualistic culture as key contributors to why students leave engineering programs. A study by Jensen and Deemer (2019) suggest that by raising awareness of the chilly climate in engineering, educators can work to create a more welcoming environment which empowers women’s confidence and success in STEM. Studies which explore hidden curriculum in engineering education suggest that explicitly recognizing the unspoken values and expectations in engineering can support the success of underrepresented populations (Villanueva et al., 2018). However, this hidden curriculum is not always explicitly addressed in engineering programs. One possible reason for not acknowledging this culture is the lack of empathy individuals feel after having endured a distressing event. Research by Ruttan et al. (2015) suggest that “people who previously endured a distressing [such as completing an engineering degree] event made less favorable evaluations of an individual failing to endure the event” (p. 610). Professors who can set aside their own biases about experiences in engineering education and explicitly recognize the challenges of engineering programs can further support students.

### **5.3. Limitations and Future Work**

This research suggest that empathic concern expressed by professors can play an important role in supporting students in engineering programs. The collection of rich qualitative data provides valuable insight into students’ perceptions of professors’ expressions of empathic concern. The results of this study can provide guidance for the

application of this teaching practice and enactment of this phenomenon by engineering professors which is transferable to other engineering programs. However, it should be noted that this qualitative research study was conducted on a limited sample of 27 students at a single research institution. Therefore, a larger sample size and additional research is necessary to be able to generalize this practice across undergraduate engineering programs. Additionally, this research focused on the reflective experiences of juniors and seniors within the College of Engineering and Computer Science majors. Further work is needed to understand the perspectives of first- and second-year students in engineering programs.

A specific limitation of this study is the lack diversity in the sample population. While this study included students from a broad range of disciplines and close to an equal number of male and female students, there was a lack of representation of underrepresented or first-generation students in the sample. This is reflective of the homogeneous nature of the engineering and computer science programs where this study was conducted. In 2018, the College of Engineering enrollment included 0.4% Black or African American students, 4% Hispanic students and 1.8 % Asian students (Office of Analysis, Assessment and Accreditation, 2020). These numbers are substantially lower than the national averages of underrepresented minorities (URMs), such as Black Americans and students of Latin American origin, who make up 4.1% and 11.1% of engineering bachelors, respectively (Yoder, 2017).

As empathic concern is a phenomenon that may be experienced differently based on an individual's background, it is essential to continue to explore the phenomenon with a more diverse population. Understanding experiences of empathic concern through the

lens of marginalized students will also help to identify better ways to support these students in engineering and to promote diversity and inclusion.

In addition, this study explored experiences of empathic concern from student perspectives on the “receiving end” of the phenomenon. In future work it will be critical to explore professors’ perspectives of this phenomenon to understand the motivation and intentions that support their expression of empathic concern. Exploring expressions of empathic concern from this lens may help to identify concerns or hesitation of faculty that may create barriers to the broad implementation of this teaching practice.

It is noteworthy to mention that some students suggested professors who were trained in education, such as faculty in engineering education, or professors who have more extensive teaching experience were more likely to demonstrate empathic concern. In future work, it would be interesting to explore the connection between training in teaching and learning and the expression of empathic concern by engineering professors. This work could be particularly important for implications in training recent graduates of research focused Ph.D. programs for future teaching roles. Explicit training on expressing empathic concern has the potential to support improved teaching practices and success of engineering students.

In some situations, students suggested there should be clear boundaries to student-professor relationship and suggested that these boundaries help to maintain professionalism in student-teacher relationships. One student commented that relationships with professors should not go beyond the bounds of campus activities or encroach on their personal life. Research by Cooper and Mines (2014) reflects this and suggest that understanding must be co-created by both students and teachers, therefore

professors can only understand as much about their students as students are willing to share. This suggest that professors may need to navigate complex and changing boundaries of student-teacher relationships and future research is needed to further explore where these boundaries lie.

Additionally, a small number of students brought up the idea of fairness, suggesting that professors' expressions of empathic concern are constrained by a need to treat students similarly. S. Meyers (2019) suggest that "effective, caring faculty members balance their connections with students by setting limits as needed, by enforcing classroom policies in consistent and equitable ways and by maintaining democratic and respectful authority in the college classroom" (p. 207). This suggests there is a delicate balance between supporting students through expression of empathic concern and treating students equally. This balance should be further explored in future research on the application of empathic concern as a teaching practice in engineering programs and how they may change as time progresses.

## CHAPTER VI

### CONCLUSION

There is an ongoing need to address issues with retention and improve graduation rates of engineering students in order to meet the growing demand for a technical workforce. To address these issues researchers have called for faculty to play a greater role in addressing the academic climate and individualistic culture of engineering education (Geisinger & Raman, 2013; Vogt, 2008). Additionally, advocates for diversity and inclusion call for a need to warm the chilly climate of engineering education and create more inclusive and welcoming cultures to support students (Jensen & Deemer, 2019; Puritty et al., 2017). This study explores the use of empathic concern as a teaching practice of engineering professors as a potential approach to warming the academic climate and supporting positive learning experiences for engineering students. Empathy is a topic of growing importance in engineering education research, however, to date this research has focused on developing students' empathy for application in engineering design (Tang, 2018). This study takes a different approach to explore how engineering professors express empathic concern as part of their teaching practice to support students. Using a conceptual framework of the components of empathic concern necessary for establishing helping relationships discussed by Rogers (1975) this study explores how empathic concern is currently being expressed by professors in engineering programs.

The results of this study suggest that expression of empathic concern from professors contribute positively to students' experiences in engineering programs. Specifically, students highlighted that positive experiences of empathic concern supported their learning, motivation, retention in engineering. While non-empathic

experiences where they wished a professor had demonstrated empathic concern challenged their persistence in engineering programs and reduced their interest in specific fields or subjects.

As part of this research study, the three components that support expression of empathic concern, including compassion, non-judgement, and understanding, were explored. It is encouraging that students who participated in this study illustrated examples of all three components in describing their experiences of empathic concern from professors. Students felt that the component of understanding supported professors' awareness of students' needs as individuals and as a whole group.

Students identified non-judgement as the component of empathic concern which allowed professors to acknowledge and validate students' individual feelings and questions in a lecture environment. However, it is important to note, that non-judgment was the least prevalent in students' descriptions which suggests a need to further improve awareness of its importance. Professors wishing to further support underrepresented students in engineering should be reflective of their own positionality and biases which could influence their interpretation of students' emotions or situations.

Finally, students described compassion as the component of empathic concern that enabled a professor to express care for students as individuals and concern for their whole class. These results suggest that the components of empathic concern including, understanding, compassion and non-judgement can be used to support individuals and groups within engineering programs. Drawing further attention to the importance of these components of empathic concern as part of the teaching practice of engineering professors can contribute to improving learning experiences for engineering students.

To further understand how empathic concern is expressed by professors in engineering programs, phenomenographic analysis of students' specific experiences was conducted. As part of this analysis, eight categories of empathic concern were identified in students' descriptions of these experiences with professors. These experiences highlight three overarching approaches to expressions of empathic concern including, (1) expressing care for students as individuals, (2) cultivating student learning, and (3) acknowledging the challenges of engineering programs. The first theme of categories focuses on professors expressing care for students as individuals. Specific categories of experiences relating to this theme including professors who take the time to understand students' individual situations and make accommodations, professor who are eager to help individual students and professors who care about students' well-being.

The second theme of categories focuses on professors' expressions of empathic concern which cultivate student learning. In these experiences, professors placed an emphasis on students' learning the subject matter rather than surviving the intensity of engineering courses. Specifically, professors demonstrate this form of empathic concern by prioritizing learning over grades through the design of their course, adjusting the pace of their course, and creating a dynamic lecture environment and safe space for asking questions. Students felt that professors who expressed empathic concern in these ways better supported their learning and success as engineering students.

The third and final theme identifies student experiences of empathic concern where a professor acknowledged the challenges of engineering programs. This theme is still emerging and suggest a continued need for engineering professors to explicitly recognize the challenges of learning new complex engineering material to support

students' self-efficacy and self-confidence. Additionally, this suggests that professors who explicitly recognize the implicit culture of engineering can help to support students. Drawing more attention to revealing elements of hidden curriculum can help to further develop inclusive and supportive environments. The specific actions and behaviors that engineering professors can apply to their teaching practice in order to express empathic concern are further discussed in the following section.

### **6.1. Implications for Practice**

By taking the time to understand the components of empathic concern necessary for building helping relationships, professors can further develop the interpersonal skills needed to develop rapport with students in their courses. While engineering professors tend to focus on the delivery of information or curricular initiatives (Christe, 2013), professors could see additional gains in learning outcomes and student retention if they attended to developing interpersonal skills that can help to foster student-professor relationships.

Research by Teven and McCroskey (1997) suggests there is a high correlation between professors who are perceived as caring and positive course evaluations. Additionally, research on teacher effectiveness in relation to emotional intelligence (EI) found a positive correlation between EI and teacher effectiveness suggesting that faculty development of emotional intelligence including skills like empathic concern could improve their effectiveness in the classroom (Jha & Singh, 2012). The development of these interpersonal skills does not diminish the need for strong technical knowledge and curricular improvements, but rather enhances the impact of efforts in these areas. Research by S. A. Meyers (2009) suggests “despite the fact that students are acutely

aware of whether their professors care about them, professors do not necessarily prioritize this aspect of teaching to the same extent” (p. 205).

Further promoting the value of the interpersonal skills needed to establish helping relationships described by Rogers (1975) may help professors enact the components of empathic concern. While this framework was initially developed within the context of psychotherapy, Rogers (1961) suggests that these conditions can support the development of supportive relationships environments in educational settings. Engineering professors who wish to implement empathic concern as part of their teaching practice would benefit from becoming familiar with Rogers’ (1975, 1961), Goleman et al.’s (2017) work, and the findings from this dissertation. These expressions of care for students as individuals can help build rapport between faculty and students which, in turn, can improve engineering students’ motivation and retention, (Micari & Pazos, 2016; Vogt, 2008).

Table 8 highlights the ways that engineering professors can implement empathic concern in their classrooms, which can serve as a guide for professors who wish to incorporate empathic concern into their teaching practice. These experiences can be grouped into three overarching themes that describe potential approaches for professors to implement empathic concern as part of their teaching practice including (1) expressing care for individual students, (2) cultivating student learning, and (3) making the challenges of engineering education explicit. The three overarching themes and the specific categories of empathic concern identified as part of this study are summarized in Table 8. For each category, recommendations for actionable ways professors can integrate empathic concern into their teaching practice are highlighted.

**Table 8:** *Recommended Actions and Behaviors to Support Empathic Concern in Engineering Programs*

Theme	Expression of Empathic Concern	Recommendations for Engineering Professors
<b>Express Care for Students as Individuals</b>	Understand individual's situations and make accommodations	<ol style="list-style-type: none"> <li>1. Take time to listen to individual students' situations</li> <li>2. Reflect on the importance of deadlines and due dates</li> <li>3. Make accommodations when they support learning</li> </ol>
	Commit to helping students succeed	<ol style="list-style-type: none"> <li>1. Establish an open-door policy or accessible office hours</li> <li>2. Encourage students to ask for help during lectures</li> <li>3. Give students your full attention when providing help</li> </ol>
	Care about students' well-being and respond non-judgmentally to emotion	<ol style="list-style-type: none"> <li>1. Acknowledge and validate students' feelings</li> <li>2. Know resources on campus to support mental health</li> </ol>
<b>Cultivate Student Learning</b>	Prioritize learning over grades through the design of course material	<ol style="list-style-type: none"> <li>1. Review and refine learning outcomes for courses</li> <li>2. Prioritize learning in designing assignments and assessments</li> <li>3. Collaborate with teaching and learning experts</li> </ol>
	Create a dynamic lecture environment and a safe space for asking questions	<ol style="list-style-type: none"> <li>1. Acknowledge and validate students' questions in a lecture environment</li> <li>2. Build connection with students by sharing personal anecdotes and learning students' names</li> </ol>
	Adjust the pace of course based on student needs	<ol style="list-style-type: none"> <li>1. Collect feedback from students throughout the semester</li> <li>2. Plan for flexible days if additional time on a topic is needed</li> <li>3. Adjust assignment due dates to support learning</li> </ol>
<b>Acknowledge Challenges of Engineering Programs</b>	Convey the challenge of learning engineering concepts	<ol style="list-style-type: none"> <li>1. Explicitly convey the challenge of learning complex engineering topics for the first time</li> <li>2. Provide opportunities to master fundamental concepts that will be needed for future success in engineering</li> </ol>
	Recognize the culture of engineering programs	<ol style="list-style-type: none"> <li>1. Understand the implicit culture of engineering programs including rigor and meritocracy</li> <li>2. Explicitly acknowledge the challenges of this culture</li> </ol>

While there are many demands on an engineering professors time, this research highlights that even small actions which demonstrate empathic concern can enrich engineering students' undergraduate academic experience. Similarly, Vogt (2008) proposes that even minor changes can make a difference and suggests that sharing personal experiences and being warm and open with students could make a positive difference in students' attitudes to learn and persist. For professors wishing to implement empathic concern, small adjustments such as having an open-door policy, welcoming questions in class, sharing personal anecdotes and explicitly recognizing the challenge of the material being covered can be perceived as caring for students. As professors advance in their expressions of empathic concern, they may wish to take on gathering feedback from students, redesign their courses to focus on learning, building rapport with individual students and integrating flexibility into course schedules. Implementing any of the examples of empathic concern highlighted as part of this study, whether small or large, has the potential to improve the learning experiences and academic climate for engineering students.

## **6.2. Final Remarks**

In reviewing the literature on supporting students in engineering programs, there are a broad range of studies that call for faculty to play a role in improving the academic culture of engineering by building rapport with students (Chen et al., 2008; Christe, 2013; Vogt, 2008). Literature in higher education that suggests expressions of empathic concern may support development of these student-professor relationships (Grantham et al., 2015; S. A. Meyers, 2009). This research suggest that empathic concern can be a powerful tool for supporting positive learning experiences when integrated as a teaching practice

among engineering professors. However, there are limited resources available that describe how to implement these practices within an engineering context.

This study highlights the ways the understanding, non-judgement and compassion can support expressions of empathic concern and describes specific experiences of empathic concern currently enacted by engineering professors. It is encouraging that all the students in this study identified positive experiences related to empathic concern. While I am aware that the use of empathic concern in teaching is well-known among educational research and practice circles, in engineering, this concept is still in its nascent stages and not well known (Baier et al., 2020; Christe, 2013). My hope is that by bringing further awareness to teaching practices, such as empathic concern, engineering professors (who typically do not have formal training in education) can implement small changes in their courses that could have a positive impact on students' experiences. Integration of even a small number of these recommendations can contribute to improving educational experiences of engineering students.

The results of this research can serve as a guide for professors wishing to implement empathic concern as part of their teaching practice. My hope is that professors in engineering will consider implementing minor changes in their courses and aim to integrate even a small number of the expressions of empathic concern highlighted in this study. By implementing small changes in their teaching practices to include these expressions professors can help to bolster the success of engineering students. Further, promoting the integration of empathic concern as a teaching practice across engineering programs can contribute to creating the inclusive and welcoming environments needed to warm the chilly climate and increase retention of engineering students.

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## APPENDICES

## APPENDIX A: RECRUITMENT INFORMATION

**Recruitment E-Mail**

IRB Protocol # 10407

Did you have a great professor who demonstrated compassion, non-judgement and understanding?

We are conducting a study to better understand how professors use empathic concern in their teaching practices and we would like to hear about your experiences in Engineering and Computer Science! We encourage students from diverse backgrounds, including women and underrepresented groups, who are currently Juniors or Seniors in the College of Engineering or who are Computer Science Majors to participate in the study.

To participate in this study, please review and sign the informed consent and respond to a short demographic questionnaire which can be found here: [Student Experiences' of Empathic Concern Demonstrated by Professors](#). This questionnaire should take no longer than 5 minutes.

After you have completed the questionnaire and provided your contact information, you can schedule an in-person or video conference interview at a time and location that is convenient for you. This interview will include 8-10 questions about your experiences with professors expressing compassion, understanding and non-judgement and should not take more than an hour of your time.

Please contact Kate Youmans ([kate.youmans@usu.edu](mailto:kate.youmans@usu.edu)) or Idalis Villanueva ([idalis.villanueva@usu.edu](mailto:idalis.villanueva@usu.edu)) with any questions or concerns about the study. This study is associated with IRB Protocol number a 10407.

## Recruitment Flyer

## Do Engineering Professors Show Empathy?



We want to hear from you!

We are conducting a study to understand how professors in engineering and computer science use compassion and understanding in their courses.

Sign Up to Share Your Experiences Here: [Student Experiences' of Empathic Concern Demonstrated by Professors](#)

#### Participants

- Must be over 18 years old
- Currently a Junior or Senior in the College of Engineering or a Computer Science Major
- Students of diverse backgrounds encouraged

#### Time Commitment

- Demographic questionnaire (5 min)
- Interview – in person or by video chat (less than 1 hour)

#### Contact Info

Kate Youmans  
Ph.D. Candidate  
Engineering Education  
[kate.youmans@usu.edu](mailto:kate.youmans@usu.edu)

Idalis Villanueva, Ph.D.  
Faculty in Engineering  
Education  
[idalis.villanueva@usu.edu](mailto:idalis.villanueva@usu.edu)

IRB Proctol # - 10407

## APPENDIX B: IRB CERTIFICATE

**Certificate of Exemption**

From: Melanie Domenech Rodriguez, IRB Chair  
Nicole Vouvalis, IRB Director

To: **Idalis Villanueva**

Date: **September 13, 2019**

Protocol #: **10407**

Title: ***A Phenomenographic Investigation of Engineering Students' Experiences of Empathic Concern Demonstrated or Expressed by Engineering Faculty***

The Institutional Review Board has determined that the above-referenced study is exempt from review under federal guidelines 45 CFR Part 46.104(d) category #2:

*Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: (i) The information obtained is recorded in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subject; (ii) Any disclosure of the responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation, or (iii) the information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and the IRB conducts a limited IRB review to make required determinations.*

This exemption is valid for five years from the date of this correspondence, after which the study will be closed. If the research will extend beyond five years, it is your responsibility as the Principal Investigator to notify the IRB **before** the study's expiration date and submit a new application to continue the research. Research activities that continue beyond the expiration date without new certification of exempt status will be in violation of those federal guidelines which permit the exempt status.

As part of the IRB's quality assurance procedures, this research may be randomly selected for audit during the five-year period of exemption. If so, you will receive a request for completion of an Audit Report form during the month of the anniversary date of this certification.

In all cases, it is your responsibility to notify the IRB **prior** to making any changes to the study by submitting an Amendment request. This will document whether or not the study still meets the requirements for exempt status under federal regulations.

Upon receipt of this memo, you may begin your research. If you have questions, please call the IRB office at (435) 797-1821 or email to [irb@usu.edu](mailto:irb@usu.edu).

The IRB wishes you success with your research.

## APPENDIX C: Reflective Prompt and Interview Protocol

### Reflective Prompt

This prompt will be provided to participants in the e-mail confirming their interview. This provides participants with the time to reflect on their experiences prior to being in an interview setting.

*As you prepare for your interview, take some time to think about your undergraduate courses. Within those courses reflect on whether an engineering or computer science professor ever demonstrated **empathic concern** towards you as a student, or towards the whole class. **Empathic concern** is demonstrated by expressing compassion, understanding, or non-judgement.*

### Interview Protocol:

[Note: In all questions “engineering” should be replaced by “computer science” when conducting interviews with computer science students.]

### Introduction & Study Purpose

First, thank you for taking the time to talk with me today me about **empathic concern** in engineering education!

The purpose of this study is to gain a better understanding of how professors use **empathic concern** as part of their teaching practice.

Before we get started, take a minute to review the reflective prompt:

*As you prepare for your interview, take some time to think about your undergraduate courses. Within those courses reflect on whether an engineering or computer science professor ever demonstrated **empathic concern** towards you as a student, or towards the whole class. **Empathic concern** is demonstrated by expressing compassion, understanding, or non-judgement.*

Do you have any questions?

In signing up for this study, you should have reviewed and signed a letter of informed consent. Do you have any questions about that letter?

I want to remind you that your participation is voluntary, and you can choose to withdraw at any time. Or if there is a question you don’t wish to answer you can just say “pass”. We will record the interview to make sure that your experiences are captured, and then recording will be transcribed. The recording will be kept confidential and any identifying information, like names, will be removed from the recording and transcripts.

There are about 10 interview questions that shouldn't take more than 45 minutes to go through. Do you have any time constraints I should be aware of?

As we get started with the interview, I wanted to let you know that we may explore experiences that were difficult or challenging for you as an engineering student and I just want to reiterate that this is a safe space where the information you share with me will be kept private and confidential. I am really interested in understanding learning about your individual experiences.

Do you have any questions or thoughts before we continue?

### Interview Questions:

1. First, can you tell me a little about yourself?
  - a. What year are you in the program and what is your major?
  - b. Why did you decide to study (insert major)?
  - c. Are you involved in any student organizations? If so which ones? What is your role in these organizations?

Shifting to the focus of our conversation....

2. Could you please describe what the concept of **empathic concern** means to you in the context of your engineering education?
3. Have you experienced a situation when an engineering professor demonstrated empathic concern towards you as an engineering student? Please describe that experience.  
*[ if participant indicates NO, skip to question 8]*

Diving further into that example ....

- a. Tell me a little bit about the course and the engineering professor?
  - i. What course? What department? How large was the class? What was the gender of the professor?
- b. Can you describe the actions or behaviors that the engineering professor used to demonstrate **compassion** towards you as a student?
- c. What can you tell me about how the engineering professor in that experience demonstrated **understanding** towards you as a student?
- d. How did the engineering professor demonstrate a **non-judgmental attitude** towards you as a student in the example you just described?

Thanks for sharing that example, I'll ask a few more questions about other times when engineering professors have demonstrated empathic concern towards a whole class.

4. Thinking about your engineering courses, are there rules or policies that indicated to you that the professor might demonstrate empathic concern?
  - a. How were these rules and policies implemented in class?
5. Can you think of a specific experience when an engineering professor expressed empathic concern towards the entire class? Please describe that experience.
  - a. Tell me a little bit about the course and the engineering professor?
    - i. What course? What department? How large was the class? What was the gender of the professor?
  - b. What can you tell me about how the engineering professor in that experience demonstrated **understanding** towards the class?
  - c. Can you describe the actions or behaviors that the engineering professor used to demonstrate **compassion** towards the class?
  - d. How did the engineering professor demonstrate a **non-judgmental attitude** towards the class in the example you just provided?
6. How did these experiences of empathic concern expressed by engineering professors impact your undergraduate engineering experience?
  - a. Was it a positive or negative impact? Why?
7. Are there any other experiences where an engineering professor expressed empathic concern that you would like to share?
8. Described a situation where you wished an engineering professor had demonstrated empathic concern towards you as a student?
  - a. What actions or behaviors do you wish that engineering professor had used to demonstrate empathic concern?
9. Do you think empathic concern has a place in engineering education? Why or why not?
10. After thinking about these experiences, can you summarize what empathic concern looks like in your engineering education experience?
11. Is there anything you feel is important that you would like to add?
12. Do you have any other questions for me?

#### Follow up questions

- Can you tell more me more about that...?
- Can you give me an example of.....?
- Can you explain what you mean by.....?
- Why was that important to you?
- Can you explain how..... relates to empathic concern?

## APPENDIX D: LETTER OF INFORMED CONSENT



Page 1 of 2  
 Protocol # 10407  
 IRB Approval Date: September 13, 2019  
 Consent Document Expires: September 12, 2022  
 Amendment #1 Approved: October 25, 2019

## Informed Consent

### A Phenomenographic Investigation of Engineering and Computer Science Students' Experiences of Empathic Concern Demonstrated or Expressed by Professors

#### Introduction

You are invited to participate in a research study conducted by Kate Youmans, a Ph.D. Candidate in Engineering Education at Utah State University under the advisement of her major advisor Dr. Idalis Villanueva. The purpose of this research is to understand from a students' perspective, how professors use empathic concern in their teaching practices. Your participation is entirely voluntary.

This form includes detailed information about the research to help you decide whether to participate. Please read it carefully and ask any questions you have before you agree to participate. Information on who to ask your questions is found at the end of the document.

#### Procedures

Your participation in this study will involve a short demographic questionnaire taking **no more than five minutes**. This questionnaire will collect demographic information including age range, race, ethnicity gender and international or first-generation student status. In addition, you will be asked about your educational standing including your undergraduate major, department, class rank and any organizations you are involved with. If you are interested in participating in the study, you will be able to sign up for an interview time through a link at the end of the questionnaire. Interviews may be conducted in person or via video-chat (through skype, g-chat etc.) and audio recordings will be collected.

The interview consists of 8-10 questions and should take **no more than 60 minutes to complete**. During the interview the researchers will ask you to describe your experiences with professors who have expressed or demonstrated empathic concern within a course context. We anticipate that 20 people will participate in this research study.

#### Risks

This is a minimal risk research study. That means that the risks of participating are no more likely or serious than those you encounter in everyday activities. The foreseeable risks or discomforts include sharing personal information with researchers, which pertains to experiences of empathy as well as the possible identification of research participants. In order to minimize these risks and discomforts, the researchers will take measures to ensure that participant feels comfortable sharing personal information and will allow the participant to select the time, location, and method (in person or video conference) of interviews. Additionally, the researchers will take steps to minimize the risk of identifying participants through the de-identification, secure and encrypted storage of data, and aggregation of findings. If you have a bad research-related experience, please contact Kate Youmans ([kate.youmans@aggiemail.usu.edu](mailto:kate.youmans@aggiemail.usu.edu)) or Idalis Villanueva ([idalis.villanueva@usu.edu](mailto:idalis.villanueva@usu.edu)).

#### Benefits

Although you will not directly benefit from this study, it has been designed to learn more about how professors use empathic concern in their teaching practice.

#### Confidentiality

The researchers will make every effort to ensure that the information you provide as part of this study remains confidential. Your identity will not be revealed in any publications, presentations, or reports resulting from this research study. However, it may be possible for someone to recognize your experience, although we will do our best to minimize this through aggregation of the experiences.



Page 2 of 2  
 Protocol # 10407  
 IRB Approval Date: September 13, 2019  
 Consent Document Expires: September 12, 2022  
 Amendment #1 Approved: October 25, 2019

We will collect your information through Qualtrics and digital audio recordings of interviews. Online activities always carry a risk of a data breach, but we will use systems and processes that minimize breach opportunities. All data collected will be securely stored in a restricted-access folder on Box.com, an encrypted, cloud-based storage system. All data collected as part of this study will be destroyed by December 30, 2022. This form will be kept for three years after the study is complete, and then it will be destroyed.

It is unlikely, but possible, that others (Utah State University, or state or federal officials) may require us to share the information you give us from the study to ensure that the research was conducted safely and appropriately. We will only share your information if law or policy requires us to do so. If the researchers learn that you are abusing/neglecting/going to engage in self harm/intend to harm another, state law requires that the researchers report this behavior/intention to the authorities.

#### **Voluntary Participation & Withdrawal**

Your participation in this research is completely voluntary. If you agree to participate now and change your mind later, you may withdraw at any time by. If you wish to withdraw your participation please contact Kate Youmans ([kate.youmans@usu.edu](mailto:kate.youmans@usu.edu)) or Dr. Idalis Villanueva ([idalis.villanueva@usu.edu](mailto:idalis.villanueva@usu.edu)). If you choose to withdraw after we have already collected information about you, the data gathered up to that point will be destroyed. The researchers may choose to terminate your participation in this research study if you no longer meet the eligibility criteria of the study, if this occurs you will be notified by e-mail.

#### **Findings & Future Participation**

Identifiers will be removed from your information prior to use on future studies. These de-identified data may be used or distributed for future research without additional consent from you. If you do not wish for us to use your information in this way, please state so below.

#### **IRB Review**

The Institutional Review Board (IRB) for the protection of human research participants at Utah State University has reviewed and approved this study. If you have questions about the research study itself, please contact the Principal Investigator at 435-797-0773 or [idalis.villanueva@usu.edu](mailto:idalis.villanueva@usu.edu). If you have questions about your rights or would simply like to speak with someone *other* than the research team about questions or concerns, please contact the IRB Director at (435) 797-0567 or [irb@usu.edu](mailto:irb@usu.edu).

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Dr. Idalis Villanueva  
 Principal Investigator  
 (435) 797-0773; [idalis.villanueva@usu.edu](mailto:idalis.villanueva@usu.edu)

Katherine L. Youmans, M.Ed.  
 Ph.D. Candidate  
 513-659-8910; [kate.youmans@usu.edu](mailto:kate.youmans@usu.edu)

#### **Informed Consent**

By signing below, you agree to participate in this study. You indicate that you understand the risks and benefits of participation, and that you know what you will be asked to do. You also agree that you have asked any questions you might have, and are clear on how to stop your participation in the study if you choose to do so. Please be sure to retain a copy of this form for your records.

## APPENDIX E: Qualtrics Survey

**Empathic Concern in Engineering Education**

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Q1

Please review the following information before decided whether to participate in this research project

*Informed Consent Is Included Here*

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Q2 After reading the above informed consent document please select a response below:

- **Yes, I am over the age of 18 and agree to participate in this study.** *If you agree to participate please type your first and last name and today's date in the text box.* (1) \_\_\_\_\_
- **No, I do not wish to participate in this study.** (2)

*Skip To: End of Survey If After reading the above informed consent document please select a response below: = <strong>No, I do not wish to participate in this study.</strong>*

**End of Block: Default Question Block**

---

**Start of Block: Demographic Questions**

Q5 Please review the questions below and select the response which most accurately describes you.

Q6 Which category most closely describes your age?

- 18-20 years old (1)
- 21-25 years old (2)
- 26-29 years old (3)
- 30-40 years old (4)
- 40 -50 years old (5)
- Over 50 years old (6)

Q7 Which category most closely describes your gender?

- ☐ Male (1)
  - ☐ Female (2)
  - ☐ Other (Please specify) (3)
- 

- ☐ Prefer Not to Say (4)

Q8 Which category most closely describes your ethnicity?

- ☐ I am not Spanish, Hispanic or Latino (1)
- ☐ I am part of a Spanish, Hispanic or Latino group (2)

Q9 Which category most closely describes your race?

- ☐ Asian (1)
- ☐ American Indian or Alaska Native (2)
- ☐ Black or African American (3)
- ☐ Native Hawaiian or Pacific Islander (4)
- ☐ White (5)
- ☐ Other (Please Specify) (6)

Q11 Which Engineering Department are you associated with?

- ☐ Mechanical Engineering (1)
- ☐ Civil and Environmental Engineering (2)
- ☐ Biological Engineering (3)
- ☐ Electrical and Computer Engineering (4)
- ☐ General Engineering (5)

Q16 What is your major?

- ☐ Biological Engineering (1)
- ☐ Civil Engineering (2)
- ☐ Computer Engineering (3)
- ☐ Electrical Engineering (4)
- ☐ Environmental Engineering (5)
- ☐ Mechanical Engineering (6)
- ☐ Other/Undecided (7)

Q12 What class rank are you?

- ☐ Freshman (0-29 Credits) (1)
- ☐ Sophomore (30-59 Credits) (2)
- ☐ Junior (60 -89 Credits) (3)
- ☐ Senior (90+ Credits) (4)

Q15 What engineering organizations are you involved with?  
Please check all that apply.

- ☐ Aggie Marine Robotics (1)
- ☐ American Society of Mechanical Engineers (ASME) (2)
- ☐ American Society of Civil Engineers (ASCE) (3)
- ☐ Biomedical Engineering Society (BMES) (4)
- ☐ College of Engineering Ambassador Program (5)
- ☐ Engineering Student Council (6)
- ☐ Engineers Without Borders (EWB) (7)
- ☐ Society of Hispanic Professional Engineers (SHPE) (8)
- ☐ Society of Women Engineers (SWE) (9)
- ☐ Tau Beta Pi Honor Society (10)
- ☐ Other (11) \_\_\_\_\_

Q13 Would you be interested in participating in a follow up interview? The interview should not last more than 45 minutes.

- ☐ Yes, I am interested in sharing more information to support the research (1)
- ☐ No I am not interested in a follow up interview. (2)

*Skip To: End of Survey If Would you be interested in participating in a follow up interview? The interview should not last... = No I am not interested in a follow up interview.*

Q17 Please provide your name and contact information so that the we can follow up to schedule an interview time.

The interview will take no more than 60 minutes and can be scheduled at a time and location (in-person or video chat) that is convenient for you.

Q18 First and Last Name

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Q19 E-Mail Address

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## APPENDIX F: INTERVIEW INCLUSION & EXCLUSIONS CRITERIA

### **Inclusion Criteria**

Data which meets this criterion will be included in the interview for analysis

1. **In Context:** Information directly related to the concepts presented in the conceptual model and the interview protocol

*Interviewer:* Great. So last question about that situation is can you describe the actions or behaviors that the engineering professor used to demonstrate compassion towards you as a student?

*Mae:* I think just that willingness to have his office open. I think that's just so important just to know that there is an open office and knowing after having had that first experience, just being able to go back and knowing that there would be help and he was completely honest in his, "I want to help when I can and I want to help you succeed," and knowing that he really did want the success. Mae - Line 205-216

2. **Follow up questions:**

- a. **Contextual Information** – follow up questions used to better understand the situation or experience that the participant is describing

*Interviewer:* Great. So, give me a little context. What's the course? What's the department? How big is the class?

*Henry:* Yeah. It's the [MAE -3000-1] course. And I'm guessing the class is about 100, but there's two sections. So, around 200 students. The homework load is pretty difficult. It's a very conceptual-based class. So, when you do homework it takes a long time, hours. And then the exams are also very difficult. So, in preparation for them, it's a lot of stress and having extra time, it's always a relief." Henry Line 134- 142

- b. **Further Probing** – following up questions which investigate dig deeper into the experience described by the participant

*Interviewer:* Great. Can you tell me a little bit about why that is important to you as a student?

*Claire:* I guess it's important to me because like when you look at a professor, it's like, oh, they're like above us. They have all this experience, they have all this knowledge and that's really like awesome that they have all that knowledge but we're nothing compared to um, what they know. And so asking questions can sometimes be really scary and intimidating but when they open up and are saying like, "All questions welcomed or if you have concerns about your assignments getting in on time, email me, text me." And just being like more of a friend than a professor. But again, there's a fine line between a friend and a professor because you still want your students to treat you as a teacher rather than taking advantage of that, I guess. Claire 193 – 211

**3. Participant Idea:** Further ideas relating to empathic concern which are brought up by the participant

*Interviewer:* Great. What does a professor do to indicate to you that you should go and get one-on-one help? We talked about that a little bit before, but you brought it up again. So, I'm curious.

*Julia:* I don't know. I never feel like it's from the professor that I'm like, "Oh, I'm not scared of you." I always feel like I call my mom and she's like, "Go to office hours." I'm like, "I know. I'm scared of the professor." So, I don't know if it's ever I feel comfortable with the professor. I think it's just honestly I know that I need help and I know I'll eventually have that personal relationship with the professor, so I won't be scared next time. So, it's always like that first time sometimes. This semester especially, I started going to office hours when I didn't need help. I would just make it a habit to go every time they had office hours and be like, "Hey, how are you? I have a dumb question. No, I don't but I need to come and talk to you so that I'm not scared of you when I actually do help later in the semester." And that was one thing that really helped me this semester. Julia 731- 745

**4. Reflective Statement:** Comments by the interviewer such as "great" "interesting" or "awesome", which reflect what the participant has stated and serves as a way to connect with the participant.

*Interviewer:* Yes. That answers that question. That's really great. So, have you experienced a situation when an engineering professor demonstrated empathic concern towards you as a student, and can you describe that experience? Caleb -Line 69

**5. Summary statements:** which reflect an idea which the participant has described previously. These statements should reflect the participant own wording as closely as possible. Instances where the interviewer introduced a connection or concept not introduced by the participant are considered "drawing conclusions" and will be excluded

*David:* Yeah, okay. So, the other example, so the one with the exam date that I had to move was all correspondence through email. So, there wasn't a lot of... There was no face-to-face interaction with that one, and so I couldn't really read a behavior too much other than the words on the page or on the screen.

*Interviewer:* Yeah. You were reading into...you know, you couldn't read into the tone behind the email. That makes sense. David – Lines 227 – 233

**6. Conversational:** These statements are intended to build rapport with the participant, which is used to make a connection with the participants experiences and make them feel comfortable in the interview setting

*Interviewer:* Cool. So, that would have been a switch right around, like, sophomore, second semester-ish?

**Ryker:** So, I had already taken the pre-reqs, and so I was taking it freshman year, first semester

**Interviewer:** Great. Okay. Awesome. Statics was boring, so you moved to electrical.” Ryker line 34 - 4

### **Exclusion Criteria:**

Data which meets the following criteria will be excluded from analysis

1. **New Idea:** Introduction of new ideas or concepts which are not in the interview protocol or conceptual model, have not been previously introduced by the participant and are not within the scope of the research question Possible examples: Motivation, Rigor, Retention

**Interviewer:** Okay. So, in that situation, do you think the class is losing rigor because he's making extensions on the homework?

**Caleb:** No, not at all. In fact, when you go up to the third floor of the engineering building, you'll see the homework plastered all over the walls, because we're all trying to work on it. Because we've learned it's most effective when he does things like this or exam reviews. If we've done the homework and understand it, then we know where our deficiencies are and we can ask questions geared on that. Otherwise, we're all standing there tooling our thumbs trying to figure out, "Well, I don't know what I don't know. Why don't you just start talking and then I'll tell you where I have questions?" And so, I don't think it's lost its rigor at all. If anything has given us a sigh of relief to say, "Okay. There's a little bit less stress. Give me some time to really try and dig in and understand the homework a little bit more," than just, "Let's get in a big group. This is how I'm working through this problem. Yeah. I think that's how you do it. Everybody worked through it together. This is all the answers we've got," but to really try and personally understand. Caleb - Line 239-252

2. **Leading Question:** Potentially leading questions which could be perceived as having a “correct” answer or which may lead participants to a specific answer will be excluded.

**Interviewer:** Let me clarify, I think. So, by rules and policies, it's like what a professor's expectations for students are. So, probably something in the syllabus.

**Caleb:** Oh, okay. Yeah.

**Interviewer:** Does that make more sense?

**Caleb:** Yeah, yeah. So, in one of my classes, [ME Professor 2] has a syllabus. And every professor has the clause that I can adjust the syllabus whenever I need to. And I mean, even just this week, he's adjusted it twice...” Caleb – Line 171-178

3. **Drawing Conclusions:** Connections or summary statements introduced by the

interviewer which go beyond the initial concept introduced by the participant. Putting words in the participants mouth?

***Interviewer:*** *Interesting. And you feel opposite about a teacher that demonstrates that empathy?*

***Anna:*** *Yeah. Mm-hmm. Anna – Line 701-103*

## APPENDIX G: CODEBOOK AND KEY COMPONENTS OF EMPATHIC CONCERN

### *Student Experiences Facilitated by the Key Component of Understanding*

<b>ID</b>	<b>Key Components</b>	<b>Expressions of Empathic Concern</b>	<b>Description</b>
1	Understanding	Recognize students have obligations outside of their engineering courses	This is demonstrated by professors who recognize that students have other obligations outside of their courses and make adjustments to the amount of course material or due dates.
2	Understanding, Compassion	Appreciate students' individual situations and make accommodations	This is demonstrated by professors who extend due dates based on student's individual circumstances, including illness, conferences, or family issues.
3	Understanding, Non-Judgement	Forgive a student's mistake when turning in assignments	This is demonstrated by professors who accept late work due to a mistake when turning it in. This often involves an issue with Canvas submissions or corrupt files.
4	Understanding	Understand what students need by gathering feedback	This is demonstrated by professors who gather feedback or input from students, either in a lecture setting or through surveys.
5	Understanding	Appreciate the difficulty of learning complex engineering concepts	This is demonstrated by professors who are able to put themselves in students' shoes and remember what it was like to learn engineering concepts for the first time.
6	Understanding	Realize the importance of learning fundamental concepts	This is demonstrated by professors who emphasize the fundamental concepts that students will need for future success in engineering. This can be done through course policies or lecture material.
7	Understanding	Recognize the need for multiple ways for students to learn	This is demonstrated by providing multiple ways of learning and resources, including review sessions, TAs, or reference materials.

*Student Experiences Enabled by the Key Component of Non-Judgement*

<b>ID</b>	<b>Key Component</b>	<b>Expressions of Empathic Concern</b>	<b>Description</b>
8	Non-Judgement	Create a safe space for asking questions	This is demonstrated by professors who encourages questions in a lecture environment and who do not respond with judgement when students ask questions.
9	Non-Judgement, Compassion	Create a dynamic and engaging lecture environment	This is demonstrated by a professor who is dynamic when lecturing, including moving around the classroom and bringing in examples or demonstrations.
10	Non-Judgement	Respond non-judgmentally to students' emotional response	This is demonstrated by the non-judgmental and compassionate response towards students who demonstrate emotions (often crying) in a one-on-one setting with a professor.

*Student Experiences Supported by the Key Component of Compassion*

<b>ID</b>	<b>Key Component</b>	<b>Expressions of Empathic Concern</b>	<b>Description</b>
11	Compassion	Recognize students as individuals and care about their well-being	This is demonstrated by professors who take the time to get to know individual students and see them as more than a number in their class.
12	Compassion	Strive to build human connection with students	This is demonstrated by professors who strive to build human connection by knowing students' names, sharing a bit about their personal experiences, and cracking jokes with students.
13	Compassion	Prioritize helping students	This is demonstrated by having lots of office hours, an open-door policy, encouraging students to ask for help, and giving students your full attention.
14	Compassion	Adjust the pace of their courses	This is demonstrated by a professor who will adjust assignment due dates or recover material to support student understanding.
15	Compassion	Emphasize learning through the design of their courses	This is demonstrated by professors who design their course or make adjustments so that students are able to focus more on understanding the material rather than earning a grade.
16	Compassion	Reduce the amount of material covered in a course	This is demonstrated through a professor's taking the time to identify and cover important course material in depth, rather than pushing through all the information in the textbook.
17	Compassion	Take accountability low assessment grades	This is demonstrated when a professor reviews the results of an assessment, takes ownership of the issues, and adjusts grades for unfair or unclear questions.

## APPENDIX H: ITERATIONS OF CATEGORIES

<b>Categories of Description - Version 1</b>			
<b>Category</b>	<b>Participants</b>	<b>Description</b>	<b>Notes</b>
Category 1	1,2,4,7,9,10,14,15,16,17,18,20,22,26,27,28	Professors who make helping students a priority	This is demonstrated by having lots of office hours that work with students' schedules, an open-door policy, encouraging student to come ask for help and giving students your full attention when they are there.
Category 2	1,8,10,11,12,14,16,17,19,20,21,22,23,24,25,	Professors who recognize that student may have personal issues outside of their control and are willing to make accommodations as needed	This is demonstrated by professors who extend due dates due to a students' individual circumstances, including illness, conferences, or family issues.
Category 3	4,6,9,13,17,18,19,23	Professors who make exceptions when a student makes a "honest" mistake turning something in	This is demonstrated by professors who accept late work due to a mistake when turning it in. This often involves an issue with canvas submissions or corruption of coding files
Category 4	1,2,5,6,8,10,16,18,24,28	Professors who seek to build relationships with students and recognize them as individuals	This is demonstrated by a professor who takes the time to get to know individual students and goes beyond seeing them as just a number in their class
Category 5	1,2,5,7,8,11,12,13,16,17,21,27,28	Professors who are personable and create a dynamic lecture environment	This is demonstrated by professors who share a bit about their personal experiences, strives to build human connection with students and who is dynamic when lecturing including moving around the classroom and bringing in examples or demonstrations
Category 6	2,5,7,8,9,10,15,18,21,25,26	Professors who are flexible with their course material in order to accommodate the pace of student learning	This is demonstrated by professors who gather feedback or input from students, either in a lecture setting or through surveys and who will adjust an assignment due date or re-cover material to support student understanding.
Category 7	2,4,5,6,7,8,11,13,14,18,20,22,23,25,27	Professors who design their course to focus on learning rather than covering material or completion of assignments	This is demonstrated by emphasis on the fundamentals, narrowing down the course material covered vs. cramming information, providing opportunities for feedback and revisions, providing multiple resources for learning, clear expectations, and adjusting assessments.
Category 8	1,4,5,7,9,11,12,14,15,16,20,21,22,28	Professors who recognize the challenges of learning engineering and create a safe space for asking questions	This is demonstrated by professors who are able to put themselves in students' shoes and remember what it was like to learn engineering concepts for the first time and who encourage dialogue and questions in a lecture environment and who do not respond judgmentally when a student asks questions

<b>Categories of Description V2</b>			
<b>Category #</b>	<b>Participants</b>	<b>Description</b>	
Category 1	1,2,4,7,9,10,14,15,16,17,18,20,22,26,27,28	Professors who make helping students a priority	1. This is demonstrated by having lots of office hours that work with students' schedules, an open-door policy 2. encouraging student to come ask for help and giving student your full attention when they are there.
Category 2	1,2,5,6,8,10,12,14,16,17,22,23,24,25	Professors who recognize that students have a life outside of class and who listened without judgement to students concerns	1. Professors who listen without judgement to students' concerns or emotions 2. Professors who recognize that students have a life outside of class
Category 3	4,6,9,13,17,18,19,23	Professors who make exceptions when a student makes a "honest" mistake turning something in	This is often tied to an issue with a canvas submission
Category 4	1,2,8,10,12,13,16,17,18,21,28	Professors who care about their students and recognize students as individuals	1. Professors who care about students as students including their success and well being 2. Professors who are personable in a lecture setting
Category 5	2,4,5,7,8,9,10,15,18,21,25,26	Professors who look for feedback from their students and adjust the pace of the course accordingly.	1. Professors who are willing to be flexible with their coursework 2. Professors who gather feedback on where students are at 3. Professors who use passements data to understand students learning gaps
Category 6	2,4,5,6,7,11,13,14,18,21,22,23,25,27	Professors who design their courses to focus on students understanding the material	1. Narrowing down material 2. Provide a variety of resources for students to get help 3. creating a dynamic lecture environment with examples and demonstrations
Category 7	1,11,14,17,19,20,22,23,27,28	Professors who understand the challenges of learning engineering	1. Professors who understand the complexity of engineering concepts 2. Professors who understand the stress of engineering programs 3. Professors who ensure students understand the fundamentals
Category 8	1,4,5,7,9,11,12,13,15,16,20,21	Professors who create a safe space for students to ask questions	1. Professors who create a safe space for students to ask questions

<b>Categories of Description V3</b>			
<b>Category #</b>	<b>Participants</b>	<b>Description</b>	<b>Notes</b>
Category 1	1,2,4,7,9,10, 14,15,16,17, 18,20,22,26, 27,28	Professors who make helping students a priority	This is demonstrated by having lots of office hours that work with students' schedules, an open-door policy, encouraging student to come ask for help and giving student your full attention when they are there.
Category 2	1,4,6,8,9,10, 11,12,13,14, 16,17,18,19, 20,21,22,23, 24,25	Professors who recognize that students have a life outside of class, or have bad days and make exceptions on student work so their grades are not punished	I wonder if this category is more about listening and caring about students? Or about extending deadlines?
Category 3	1,2,5,6,8,10, 12,13,16,17, 18,21,28	Professors who are personable and care about their students as individuals including their wellbeing and success.	1. Feeling like a person and not a number 2. Willing to listen to students' emotions/feeling w/o judgement 3. Personable in a classroom setting
Category 4	2,4,5,7,8,9,1 0,15,18,21,2 5,26	Professors who look for feedback from their students and adjust the pace of the course accordingly.	
Category 5	2,4,5,6,7,8,1 1,13,14,18,2 0,21,22,23,2 5,27	Professors place an emphasis on students understanding through the design of their course.	1. Narrowing down material 2. Provide a variety of resources for students to get help 3. Place an emphasis on fundamentals 4. Evaluate assessment for effectiveness 5. Creating a dynamic lecture environment with examples and demonstrations
Category 6	1,4,5,7,9,11, 12,13,14,15, 16,20,21,22, 28	Professors who understand the complexity of engineering concepts and creates a safe space for student to ask questions in class or office hours.	1. Understands the complexity of engineering concepts 2. Safe space to ask questions in class

Categories of Description V4			
Category #	Participants	Description	
Category 1	1,2,4,7,9,15,16,18,20,22,24,26,27,28	Professors who are eager to help students succeed in the course on an individual basis and ask "what can I do to help?"	This is demonstrated by having lots of office hours that work with students schedules, an open-door policy, encouraging student to come ask for help and giving student your full attention when they are there.
Category 2	2,8,10,16,22,23,28	Professors who listen and are non-judgmental and compassionate when students are emotional or share challenging personal problems	This is demonstrated by professors who take the time to listen non-judgmentally to struggling students' personal situations or emotions and who may demonstrate compassion by extending the dealing. The focus here is on listening rather than extending a deadline
Category 3	2,4,5,6,9,12,13,17,19,21,24,25	Professors who understand that students have personal situations or make mistakes and are compassionate by accepting late work.	This is demonstrated by taking the time to understand individual students' situations and make exception when students have a personal situation or make a mistake when turning something in.
Category 4	1,5,6,8,9,11,12,13,16,21,27	Professors who create a dynamic and engaging lecture environment which supports open dialogue and human connection	This is demonstrated by professors who create open dialogue in their classroom, who share personal experiences, engage students in relevant examples or demonstrations and seek to build connections with individual students so they feel like a person and not just a number in the classroom.
Category 5	2,4,7,8,9,10,15,16,17,18,20,21,25,26	Professors who gather feedback from students and are flexible with the course pace and assignment due dates	This is demonstrated by professors gathering input or checks for understanding from the class and making adjustments depending on students' stress levels or pace of understanding
Category 6	2,5,6,7,10,11,13,18,22,25	Professors who place an emphasis on learning and understanding through the design of their course work and assignments	This is demonstrated by professors who take the time to design effective coursework including: 1. Narrowing down material 2. Provide a variety of resources for students to get help 4. evaluate assessment for effectiveness 5. creating a dynamic lecture environment with examples and demonstrations
Category 7	1,4,5,7,14,15,16,20,22,23,27,28	Professors who demonstrate empathy when they understand the difficulty of learning engineering concepts	This is demonstrated through an emphasis on fundamentals and non-judgement of students' questions

Categories of Description V5			
Category #	Participants	Description	
Category 1	1,2,4,7,9,15,16,18,20,22,24,26,27,28	Professors who are eager to help students succeed in the course on an individual basis - demonstrated through office hours "what can I do to help?"	This is demonstrated by having lots of office hours that work with students' schedules, an open-door policy, encouraging student to come ask for help and giving student your full attention when they are there.
Category 2	2,8,10,13,15,16,28	Professors who take the time to listen without judgement and respond compassionately to students' personal challenges or emotions.	When a professor goes above and beyond to support struggling students, which are often expressed by crying or emotions during office hours
Category 3	4,5,6,9,12,17,19,21,23,24,	Professors who understand students' individual circumstances and are willing to be flexible with due dates so that students grades accurately reflect their understanding rather than an mistake or personal situation	This is demonstrated by taking the time to understand individual students' situations and make exception when students have a personal situation or make a mistake when turning something in.
Category 4	1,5,7,8,9,11,12,13,15,21,22,27	Professors create a dynamic and engaging lecture environment which supports open dialogue and human connection	This is demonstrated by professors who create open dialogue in their classroom, who share personal experiences, engage students in relevant examples or demonstrations and seek to build connections with individual students so they feel like a person and not just a number in the classroom.
Category 5	2,4,16,18	Professors who are aware of their students' stress levels and learning and adjust the pace of the course and assignments accordingly	This is demonstrated by professors gathering input or checks for understanding from the class and making adjustments depending on students' stress levels or pace of understanding
Category 6	2,5,6,7,9,10,11,13,18,20,21,25,26	Professors who place an emphasis on learning through the design of their course and assignments	This is demonstrated by professors who take the time to design effective coursework including: 1. Narrowing down material 2. Provide a variety of resources for students to get help 4. evaluate assessment for effectiveness 5. creating a dynamic lecture environment with examples and demonstrations

Category 7	1,4,5,7,8,9,14,15,16,20,22,23,27,28	Professors who understand the difficulty of learning engineering concepts and place an emphasis on fundamental skills	This is demonstrated by professors who create open dialogue in their classroom, who share personal experiences, engage students in relevant examples or demonstrations and seek to build connections with individual students so they feel like a person and not just a number in the classroom.
Category 8	1,14,17,19,21,24,25	Professors who recognize the stress of engineering programs and see their course in the larger scope of a students' life	This is demonstrated through an emphasis on fundamentals and non-judgement of students' questions

<b>Categories of Description V6</b>			
<b>Category</b>	<b>Participants</b>	<b>Label</b>	<b>Description</b>
<b>Theme: Professors who care about students as individuals</b>			
Category 1	1,2,4,7,9,15,16,18,20,22,24,26,27,28	Professors who make helping students a priority	This is demonstrated by being eager to help students, encouraging students to come ask for help, having an open-door publicity, or office hours which accommodated students schedules, and giving students your full attention when they are there
Category 2	2,8,10,13,15,16,22,23,28	Professors who recognize students as individuals, work to build human connection and care about students' well-being	This is demonstrated by professors who recognize students as individuals rather than just a number in their course, professors who strive to build human connection with students by sharing their personal experiences and by professors who take the time to listen without judgement to students' personal challenges or emotions (often expressed through crying). These professors act compassionately towards students by supporting their wellbeing as both a student and a person.
Category 3	4,5,6,9,12,13,17,19,21,22,23,24,25	Professors who take time to understand students' individual circumstances and make accommodations	This is demonstrated by professors who take the time to understand students' personal circumstances, including illness, family situations, travel, or mistakes and are willing to be flexible with assignments so that students grades accurately reflect their understanding.
<b>Theme: Professors who place an emphasis on student learning</b>			
Category 4	2,5,6,7,9,10,11,13,18,20,21,25,26	Professors who place an emphasis on learning through the design of their course and evaluations	This is demonstrated by professors who take the time to derive effective coursework including: narrowing down material, evaluating the effectiveness of assessments, providing a variety of resources for additional help.
Category 5	1,2,4,5,7,8,9,10,14,15,16,17,18,19,20,21,25,26	Professors who are flexible and adjust the pace of their course to accommodate student learning and stress levels	This is demonstrated by professors who are aware of where there students are at, either by asking for feedback or checking for understanding and are willing to adjust the pace of their course or due dates based on need for additional time on a topic or student stress level
<b>Theme: Professors who understand the challenges of Engineering Education</b>			
Category 6	1,4,5,7,8,9,14,15,16,20,22,23,27,28	Professors who understand the difficulty of learning engineering concepts and place an emphasis on fundamental skills	This is demonstrated by professors expressing understanding of the difficulty of learning engineering concepts and placing an emphasis on the fundamental skills students will need for their future success in engineering.
Category 7	1,4,5,6,7,8,9,11,12,13,15,16,21,22,27	Professors who create a dynamic and engaging lecture environment which creates a safe space for asking questions	This is demonstrated by professors who create open dialogue in their classroom, engage students in relevant examples or demonstrations, and respond positively to students' questions, including answering them without judgement

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**Categories of Description - Version 7 (Final)**


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Category	Professors Who:	Description	Participants
Category 1	Understand individuals' situations & make accommodations	This is demonstrated by professors who see their course in the larger context of students' lives. They take the time to understand students' personal circumstances, including illness, family situations, travel, or mistakes, and are willing to be flexible with assignments and due dates so that students' grades accurately reflect their understanding.	<p><i>Total: 13</i> <i>(Female: 4 Male: 9)</i></p> <p>Claire, David, Wren, Ryker, Jane, Nolan, Alice, Xavier, Henry, Kai, Charlie, Sebastian, Liam</p> <p><i>Components: Understanding &amp; Compassion</i></p>
Category 2	Commit to helping students succeed	This is demonstrated by professors who are eager to help individual students outside of class time. They encourage students to come ask for help, have an open-door policy, or office hours which align with student schedules, and give students their full attention.	<p><i>Total: 14</i> <i>(Female: 8 Male: 6)</i></p> <p>Caleb, Anna, Claire, Thomas, Ryker, Rose, Cora, Elise, Noah, Lily, Sebastian, Grace, Luke, Mae</p> <p><i>Components: Compassion, Understanding, Non-judgement</i></p>
Category 3	Care about students' well-being & respond non-judgmentally to emotion	This is demonstrated by professors who strive to build human connection with students and care about their well-being as both a student and a person. In these experiences, professors take the time to listen, without judgement, to students' personal challenges, feelings or emotions, and often crying.	<p><i>Total: 8</i> <i>(Female: 8 Male: 0)</i></p> <p>Anna, Wren, Hazel, Julia, Jane, Cora, Lily, Mae</p> <p><i>Components: Compassion, Non-Judgment</i></p>
Category 4	Prioritize learning over grades through the design of course material	This is demonstrated by professors who prioritize students' understanding of the material over the completion of tasks. This includes narrowing down material, allowing revisions and extra credit on assignments, evaluating assessments, providing a variety of learning resources, and setting clear expectations.	<p><i>Total: 12</i> <i>(Female: 5 Male: 7)</i></p> <p>Caleb, Anna, David, Wren, Thomas, Julia, Ben, Nolan, Elise, Lily, Charlie, Liam</p> <p><i>Components: Understanding, Compassion</i></p>

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Category	Professors Who:	Description	Participants
Category 5	Create a dynamic lecture environment and a safe space for questions	This is demonstrated by professors who create an open dialogue in their classroom, engage students in relevant examples or demonstrations, and respond positively to students' questions, including answering them without judgment.	<p><i>Total: 14</i> <i>(Female: 6 Male: 8)</i></p> <p>Anna, Claire, David, Thomas, Ryker, Julia, Rose, Xavier, Elise, Henry, Noah, Kai, Liam, Grace</p> <p>Components: Non-Judgment, Compassion</p>
Category 6	Adjust the pace of their course based on student needs	This is demonstrated by professors who are aware of where their students are at, either by asking for feedback or checking for understanding, and are willing to adjust the pace of their course or due dates to support student understanding of a topic.	<p><i>Total: 14</i> <i>(Female 5, Male: 9)</i></p> <p>Caleb, Claire, David, Thomas, Hazel, Ryker, Ben, Jane, Nolan, Rose, Cora, Kai, Luke</p> <p>Components: Understanding, Compassion</p>
Category	Professors Who:	Description	Participants
Category 7	Convey the challenge of learning engineering concepts	This is demonstrated by professors who remember what it was like to learn engineering concepts for the first time and understand the difficulty of learning these complex concepts. In addition, these professors support student success in engineering by emphasizing fundamental concepts.	<p><i>Total: 8</i> <i>(Female: 4 Male: 4)</i></p> <p>Caleb, Alice, Cora, Noah, Lily, Charlie, Luke, Mae</p> <p>Components: Non-Judgement, Understanding</p>
Category 8	Recognize the culture of engineering programs	This is demonstrated by professors who recognize the culture of engineering including emphasis on rigor and meritocracy.	<p><i>Total: 5</i> <i>(Female: 0 Male :5)</i></p> <p>Ben, Xavier, Henry, Noah, Kai</p> <p>Non-Judgement, Compassion</p>

## APPENDIX I: CURRICULUM VITAE

**KATE YOUMANS**

814 Downington Ave  
Salt Lake City, UT 84105

kate.youmans@usu.edu  
513-659-8910

**Professional Summary**

Innovative educational leader & diversity and inclusion advocate with 10 years of experience leading research-based programs to support underrepresented student' success in STEM.

**Education**

**PhD Engineering Education** June 2020  
**Utah State University – Logan, Utah**  
Dissertation: “A Phenomenographic Investigation of Engineering Students’ Experiences of Empathic Concern Demonstrated or Expressed by Professors”  
Advisor: Dr. Idalis Villanueva

**MEd Science Education** May 2014  
**Boston University – Boston, MA**  
Concentration: Project Based Learning in STEM  
Advisor: Dr. Donald DeRosa

**BS Mechanical Engineering** May 2004  
**Worcester Polytechnic Institute – Worcester, MA**  
Concentration: Biomaterials  
Graduated with Distinction

**Professional Development**

**Leading for Equity, Diversity and Inclusion in Higher Education** In Progress  
**University of Michigan - Online**  
Certificate course to understand institutional structures and transformative strategies to support diversity and inclusion in higher education

**Academic Leadership for Women Engineers (ALWE)** 2018  
**Society of Women Engineers Conference – Minneapolis, MN**  
Selected for an intensive training for women in engineering with leadership potential

**LGBTQA+ Ally Training** 2018  
**Utah State University – Logan, Utah**  
 Training to advocate for the LGBTQA+ community on and off campus

**Frontiers in Education Doctoral Symposium** 2018  
**IEEE Conference – San Jose, CA**  
 Selected to participate in the collaborative development of dissertation proposals

### **Research Experience**

**Dissertation Research** 2019  
**Department of Engineering Education – Utah State University, Logan, UT**  
 Advisor: Dr. Idalis Villanueva

- Using a phenomenographic methodology this study seeks to understand how *empathic concern* could be used by engineering and computer science professors to support diverse student populations
- Completed the IRB approval process and developed a qualitative interview protocol through an iterative pilot study

**Graduate Student Researcher** 2017- Present  
**Department of Engineering Education – Utah State University, Logan, UT**

**Advocating for Engineering through Hidden Curricula: A Multi- Institutional Mixed Methods Approach (NSF BPE CAREER Grant; PI: Dr. Idalis Villanueva)**

- Collaborated on the development of a mixed methods survey to understand mechanisms of hidden curriculum and their impact on underrepresented populations
- Contributed to qualitative analysis conducted to understand the role of emotions, self-efficacy and advocacy in unveiling hidden curriculum

**The Making of Engineers: Influence of Makerspaces on the Preparation of Undergraduate Engineers (NSF RFE Grant, Co-PI: Dr. Idalis Villanueva)**

- Created interview and observational protocols and led three site visits to collect data from faculty, students and staff in makerspaces
- Developed codebook and theoretical framework to investigate the culture and characteristics of makerspaces which support the development of engineering students

## **STEM Education Leadership**

### **Director –STEM Programs**

2014 – 2017

#### **American International School of Utah – Salt Lake City, UT**

- Administrative team member responsible for opening a new charter school with 1300 K-12 students, focused on personalized and hands-on learning experiences
- Established and implemented the vision and strategy for a progressive K-12 STEM program that engaged students in interdisciplinary programs in Design Thinking, Robotics, and Computer Science courses and programs
- Cultivated a collaborative team of six teachers by establishing a cooperative culture in the STEM programs which led to creativity and innovation in the department
- Secured \$92,700 in grants from the STEM Action Center for development of computer science programs and courses in robotics and engineering design
- Developed curriculum and taught technical courses in engineering for middle and high school students, including an advanced capstone design course
- Designed interdisciplinary programs to empower young women in STEM including learning math through dance and outdoor experiential courses

### **Manager – Middle School Programs**

2010 – 2013

#### **Office of Engineering Outreach, MIT School of Engineering – Cambridge, MA**

- Collaborated with faculty and staff at MIT to develop innovative K-12 outreach programs to inspire interest and increase diversity in science and engineering fields
- Managed two intensive summer programs which engaged over 120 underrepresented middle school students in STEM enrichment courses
- Selected, trained and mentored an instructional staff of 24 diverse undergraduate students
- Established a fun and engaging culture with curriculum focused on active learning activities including dodgeball robots, electric-slide algebra and chemistry of candy
- Led initiatives to evaluate programs in a qualitative manner, drawing specific conclusions and formulating program improvements based on data
- Increased number of applications by 30% through refined marketing, electronic communication, and social media tools
- Managed budgets and resources allocation along with developing proposals and reports to support fundraising for programs

## **Teaching Experience**

### **Introduction to Engineering**

Instructor 2019

#### **College of Engineering – Utah State University – Logan, Utah**

Lead TA, 2017

Developed and taught course sequence, lecture material, activities & final design project for 45 engineering students.

**Engineering Instructor**

2014- 2017

**American International School of Utah (AISU), Salt Lake City, UT**

Designed and implemented interdisciplinary courses to support student development

***High School Courses:***

Introduction to Engineering Design  
 Capstone Design Course  
 Biomedical Engineering  
 Industrial Design

***Middle School Courses:***

Introduction to Engineering (PLTW)  
 Robotics and Automation (PLTW)  
 3D Design and Modeling (PLTW)  
 SHINE – Integrated Math & Dance Course  
 GEMS – Girls Exploring Mountains Outdoor  
 Experiential Course

***Capstone Design Projects Supervised:***

- Biomedical engineering student designed an assistive device for open-heart surgery
- Industrial design teaching assistant developed a drone with gimbal video mount
- Capstone student interested in bikes designed a motorized drift trike and velomobile
- Capstone student interested in humanitarian design created portable homeless shelter

**Industry Design Experience****Project Manager & Design Engineer**

2007-2010

**Accellent Inc. – Wilmington, MA**

- Delivered medical device projects from conceptualization through product launch including re-launch of endoscopic devices and development of spinal cord simulator
- Established positive relationships with customers and sales team as the key point of contact for technical and project management discussions
- Demonstrated effective leadership and communication skills to build consensus and drive collaborative decisions in team settings
- Established attainable project schedules and managed project expenses up to \$1.5 million

**Associate Design Engineer**

2004- 2007

**Ethicon-Endo Surgery – a Johnson and Johnson Company – Cincinnati, OH**

- Managed production and evaluation of prototypes for concept selection of biopsy system
- Coordinated electrical, mechanical, and controls system integration for prototype builds
- Oversaw the production, qualification and implementation of components and equipment
- Led collaboration between pre-clinical partners, international surgeons, and R&D team through clinical procedure development and pre-clinical studies

### **Honors and Awards**

**Graduate Student Researcher of the Year** 2019  
Engineering Education Department – Utah State University

**Distinguished Paper Award – Co-Author** 2018  
Northern Rocky Mountain Educational Research Association Conference 2018

**Best Practices in STEM – Model Educator** 2015  
School Improvement Network – Utah Statewide Improvement in STEM

**Inspiring Engineering Educator Award** 2014  
Runner Up – Discover E

### **Grants and Fellowships**

**Dissertation Fellowship (\$2,500)** 2019  
School of Graduate Studies – Utah State University  
Support for dissertation based on academic performance and accomplishments

**International Travel Award (\$400)** 2019  
School of Graduate Studies – Utah State University – Support for travel to  
European Society of Engineering Education Conference in Budapest, Hungary

**Doctoral Student Travel Award (\$300)** 2019  
College of Engineering – Utah State University – Support for travel to  
European Society of Engineering Education Conference in Budapest, Hungary

**Graduate Student Travel Award (\$300)** 2018  
School of Graduate Studies – Utah State University  
Support for travel to IEEE Frontiers in Education Conference in San Jose, CA

**Student Travel Award (\$1,000)** 2018  
International Symposium of Academic Makerspaces  
Support for travel to ISAM annual meeting in Palo Alto, CA

**Merit Scholar (\$28,250)** 2013  
School of Education – Boston University  
Scholarship for tuition based on past achievements and potential for future success

## **Publications**

### **Refereed Journal Publications:**

1. Lenhart, C., Bouwma-Gearhart, J., Villanueva, I., **Youmans, K.**, & Nadelson, L, Engineering Faculty Perceptions of University Makerspaces: Potential Affordances for Curriculum, Instructional Practices, and Student Learning, *International Journal of Engineering Education*, 2019
2. I. Villanueva, M. Di Stefano, L. Gelles, **K. Youmans**, & A. Hunt. (2019). Upending previously hidden engineering messages for empowerment (UPHEME): Development and initial validation of an instrument to quantify hidden curriculum stages for engineering students and faculty. *International Journal of STEM Education Research, Under Review*, 2019
3. I. Villanueva, J. Husman, D. Christensen, **K. Youmans**, M.T.H. Khan, P. Vicioso, S. Lampkins, & M. Graham. A cross-disciplinary and multi-modal experimental design for studying near real-time authentic examination experiences. *Journal of Visualized Experiments*, 2019
4. J. Husman, I. Villanueva, S. Lampkins, D. Christensen, **K. Youmans**, & P. Vicioso. If I value the engineering test do I feel more or less shame when I fail?: The interaction between performance assessments, value, & academic emotions. *Journal of Engineering Education* (2019, under review)

### **First Author Refereed Conference Papers:**

1. **K. Youmans**, R. Campos, L. Campos, I. Villanueva, J. Bouwma-Gearhart, C. Lenhart, & L. Nadelson. (2019). Professionalism in engineering prototyping centers: an exploratory study. *Northern Rocky Mountain Educational Research Association Conference, October 2019, Denver, CO*.
2. **K. Youmans**, I. Villanueva, L. Nadelson, J. Bouwma-Gearhart, A. Lenz, & S. Lanci. Makerspaces vs. engineering shops: initial undergraduate student perspectives. *IEEE Frontiers in Education Conference*, October 2-6, 2018, San Jose, CA.
3. **K. Youmans**, I. Villanueva, L. Nadelson, J. Bouwma-Gearhart, A. Lenz, & S. Lanci. Engineering students' perceived value of makerspaces in relation to future career preparation. *International Symposium on Academic Makerspaces*, August 3-5, 2018, Stanford, CA.
4. **K. Youmans** & I. Villanueva. Engineering and... : Women negotiating their future in the present. *Gender in STEM conference*, July 31-August 2, 2018, Eugene, OR.
5. **K. Youmans** & E. Cagin. Gender Equitable Introduction of Engineering in Middle Schools, Methods of Assessment. *Institute of Electrical and Electronics Engineering (IEEE) Conference*, June, 2003 Cyprus.

### Additional Refereed Conference Papers:

1. L. Gelles, **K. Youmans**, I. Villanueva, & (2019). Sparking Action: How Emotions Fuel or Inhibit Advocacy around Hidden Curriculum in Engineering, *European Society of Engineering Education (SEFI)*, Budapest, Hungary, September 16-19, 2019
2. L. Gelles, **K. Youmans**, I. Villanueva & M. Di Stefano. (2019). Hidden Curriculum Advocacy and Resources for Graduate Students in Engineering. *CONECD Conference, Crystal City, VA*, April 14-17, 2019
3. I. Villanueva, L. Gelles, M. Di Stefano, & **K. Youmans**. (2019). Developing a mixed-method survey to explore hidden curriculum in Engineering Education. *Northern Rocky Mountain Educational Research Association Conference, October 2019, Denver, CO*.
4. L. Nadelson, I. Villanueva, J. Bouwma-Gearhart, **K. Youmans**, S. Lanci, & C.A. Lenhart. Knowledge in the making: what engineering students are learning in makerspaces. *American Association of Engineering Education, Design in Engineering Education Division*, June 15-19, 2019, Tampa, FL.
5. J. Bouwma-Gearhart, I. Villanueva, L. Nadelson, S. Lanci, **K. Youmans**, & C.A. Lenhart. University makerspaces and faculty practices: potential affordances for diverse students' STEM role identity development, *NARST*, 2019, Baltimore, MD,
6. J. Husman, M.C. Graham, I. Villanueva, D. Christensen, **K. Youmans**, S. Lampkins, R. Wright, & B. Bermudez. Connecting to the future, feeling better in the present: academic achievement emotions, future oriented value, & arousal. *American Educational Research Association*, April 5-9, 2019, Toronto, Canada.
7. D. Christensen, I. Villanueva, J. Wheeler, P. Vicioso, J. Husman, S. Lampkins, & **K. Youmans**. Exploring potential relationships between self-efficacy, performance, and electrodermal activity in engineering exams, *American Educational Research Association*, April 5-9, 2019, Toronto, Canada.
8. I. Villanueva, M. Di Stefano, L. Gelles, & **K. Youmans**. Exploring how engineering faculty, graduates, & undergraduates evaluate hidden curriculum via emotions & self-efficacy. *Northern Rocky Mountain Educational Research Association Conference*, October 17-19, 2018. Salt Lake City, UT (poster presented; paper under review).  
\*received Distinguished Paper Award\*
9. I. Villanueva, M. Di Stefano, L. Gelles, & **K. Youmans**. Hidden curriculum awareness: a qualitative comparison of engineering faculty, graduate students, and undergraduates. *World Engineering Education Forum*, November 12-16, 2018, Albuquerque, NM,

10. I. Villanueva, L. Nadelson, J. Bouwma-Gearhart, **K. Youmans**, S. Lanci, & A. Lenz. Exploring students' & instructors' perceptions of engineering: case studies of professionally-focused & career exploration courses, *Proceedings of the American Society of Engineering Education Annual Conference & Exposition, Liberal Education/Engineering Studies Division*, June 24-27, 2018, Salt Lake City, UT
11. S. Lanci, L. Nadelson, J. Bouwma-Gearhart, I. Villanueva, **K. Youmans**, & A. Lenz. Developing a measure of engineering students' makerspace learning, perceptions & interactions. *2018 Proceedings of the American Society of Engineering Education Annual Conference & Exposition*, June 24-27, 2018, Salt Lake City, UT, Paper ID # 22089
12. Husman, S. Lampkins, I. Villanueva, D. Christensen, P. Vicioso, & **K. Youmans**. (2018). If I value the test do I feel more or less shame when I fail? Exploration of value and emotions. *Poster Presented at the International Conference on Motivation*, August 15-17, 2018, Aarhus, Copenhagen, Denmark.

### **Patents**

ALBRECHT, Thomas E.; (US)., ORTIZ, Mark S.; (US).PLESCIA, David N.; (US).STOKES, Michael J.; (US).**YOUMANS, Katherine L.**; (US).VOEGELE, James W.; (US). ZEINER, Mark S.; (US).HARRIS, Jason L.; (US) Patent WO/2008/208108 An implantable coil for insertions into a hollow body organ

### **Professional Affiliations**

<b>Women in Engineering ProActive Network</b>	2019 – Present
CoNECD Paper Reviewer – 2018 & 2019	
<b>American Society of Engineering Education</b>	2015 – Present
Paper Reviewer 2017, 2018, 2019	
<b>Society of Women Engineers</b>	2004 – Present
Outreach Project Lead 2006 – 2009	
<b>Tau Beta Pi</b> (National Engineering Honor Society)	Inducted 2003
<b>Alpha Phi Omega</b> (National Co-Ed Service Fraternity)	Inducted 2002