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Engineering faculty views of teaching quality, accreditation, and institutional climate and how they influence teaching practices

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ENGINEERING FACULTY VIEWS OF TEACHING QUALITY, ACCREDITATION, AND INSTITUTIONAL CLIMATE AND HOW THEY INFLUENCE TEACHING PRACTICES

A Dissertation

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For my family

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ABSTRACT

McNeil, Jacqueline C. Ph.D., Purdue University, December 2014. Engineering Faculty Views of Teaching Quality, Accreditation, and Institutional Climate and How They Influence Teaching Practices. Major Professor: Matthew Ohland.

There is wide agreement that teaching quality matters in higher education, but faculty have varied ideas about the definition of quality. This dissertation examined data from a survey administered in 1997, 1999, and 2002 at institutions of the Southeastern University and College Coalition for Engineering Education (SUCCEED) supplemented by a survey administered more recently to a subset of those institutions and two additional institutions. All participating institutions are large public universities. The data collected included faculty teaching practices and three influences on those practices—the faculty member's definition of quality teaching, their perspective on ABET accreditation processes, and the climate for teaching at their institution, resulting in a dissertation in a three-paper format.

"**Engineering Faculty Perspectives on the Nature of Quality Teaching**" examines definitions of quality teaching. Using thematic analysis, these were coded according to a framework for quality in higher education by Harvey and Greene. Multinomial logistic regression showed that views on quality teaching were associated with faculty teaching practices. The most common definition of teaching quality (held by 49 percent of

participants) is associated with elitism and restricted access—the best way to improve education is to admit better students. These faculty focus on education as "knowledge transfer" and "learning content." Another 38 percent of faculty had a transformational perspective, more focused on process than content, valuing "empowering students," "developing students," and "creating an environment for learning." These faculty refer pedagogies of engagement such as active learning. The only other prevalent definition of quality (30 percent of faculty) focused on "fitness for purpose," characterized by terms such as "ability to meet specific legitimate learning objectives" and "mastery of learning outcomes." This work provides guidance to faculty development efforts.

"**The Influence of ABET Accreditation Practices on Faculty Approaches to Teaching**" explores the effect of ABET accreditation on quality teaching as described in faculty comments from 2014 using thematic analysis. Multinomial logistic regression related faculty perspectives on accreditation terminology and processes to faculty teaching practices. Faculty had overwhelmingly negative views regarding accreditation, believing that it adds to their workload, stifles their creativity, and distracts them from other important objectives including teaching. Faculty who express various negative views of either the goals or the practice of accreditation are less likely to engage in certain student-centered teaching practices. More positively, our findings show that faculty who tend agree with the student-outcomes focus of the ABET criteria engage in richer educational experiences—they give students more writing assignments and allow students to learn collaboratively.

"**Faculty Perspectives and Institutional Climate for Teaching Quality in Engineering**" analyzes faculty comments from the earlier surveys using thematic analysis. Comments from the 2014 survey were classified by teaching practices (traditional vs. non-traditional) and institutional climate (traditional vs. non-traditional), creating four cases. These comments were then analyzed using a collective case study approach. The study of the two collections of open-ended comments was supplemented by multinomial logistic regression of survey items from the 2014 administration relating faculty teaching practices and the institutional climate for teaching. In the historical data, faculty views of student evaluations evolved from seeing it as a negative burden to describing is as positive evidence of student learning. Faculty comments included many references to administrators who only "pay lip service" to the importance of teaching, although some faculty spoke positively about their campus' commitment to quality teaching. Faculty awareness of and pressure to use student-centered methods increased with time. The collective case study identified faculty in all four conditions, although they were not equally prevalent, and illustrates the experience in each condition using faculty comments.

CHAPTER 1. INTRODUCTION

1.1 Introduction

This dissertation presents three distinct ways that faculty perceptions of the nature of quality can affect their teaching. This dissertation focuses on the intrinsic barriers to quality teaching in engineering classrooms—why faculty make the decisions they make about teaching.

There is a national call for change. America has been concerned about how we teach engineering students and are calling for more student-centered teaching in our classrooms: From Analysis to Action (NRC, 1996), Shaping the Future (NSF, 1996), and Transforming Undergraduate Education in Science, Mathematics, Engineering, and Technology (NRC, 1999).

Research has shown that student-centered pedagogies have advantages. Actively engaging students in learning helps them enjoy the classes, which, consecutively, keeps the students in the degree program, these pedagogies have been shown to retain minorities and women at a higher rate, and to learn the material at a deeper level (Astin, 1993; Cabrera, Nora, Bernal, Terenzini, & Pascarella, 1998; Cooper, 1990, Gamson, 1994; Goodsell, 1992; Johnson, Johnson, & Smith, 1991; Kulik, Kulik, & Cohen, 1979;

Levine & Levine, 1991; McKeachie, 1986; McKeachie, 1990; Murray, 1998; Pascarella & Terenzini, 1991; Prince, 2004).

Many engineering faculty have been slow to change to student-centered pedagogy, and as such, there are many research efforts on getting faculty to change to student-centered pedagogy (Felder, 1995; Felder & Brent, 1994; Prince, 2004; Riley, 2003; Smith, Douglas, Cox, 2009; Smith, Sheppard, Johnson, & Johnson, 2005; Wankat & Oreovicz, 1993). Recent research surveyed U.S. engineering department heads and found that many faculty are aware of student-centered teaching methods but are not using them (Borrego, Froyd, Henderson, Cutler, Prince, 2013). This research adds to that understanding by exploring three important influences on the decisions faculty make about teaching methods: faculty perceptions of quality teaching, faculty views of the accreditation process, and the department climate for teaching.

The original research design was to extend previous work in the Southeastern University and College Coalition for Engineering Education (SUCCEED) to study faculty pedagogical choices in 1997, 1999, 2002, and 2014 and to describe the influences on those pedagogical choices. From 1992 to 2002, SUCCEED was funded as an NSF-sponsored coalition of eight colleges of engineering to promote a reform movement within engineering education. The coalition consisted of: Clemson University, Florida A&M University—Florida State University (joint College of Engineering), Georgia Institute of Technology, North Carolina State University, North Carolina A&T State University, University of Florida, University of North Carolina at Charlotte, and Virginia

Polytechnic Institute and State University. The SUCCEED coalition had included efforts to improve faculty preparedness to use and change faculty perspectives on student-centered pedagogies.

The original research project was to analyze the reconfigured survey responses from 2014 and explore any changes at the original SUCCEED institutions in the past 12 years—changes in the teaching methods used, changes to the climate in which faculty teach, or thematic changes in open-ended comments. Additional questions were added to probe faculty definitions of quality teaching and the effect of the accreditation process on their teaching quality. Additional institutions were invited to participate to further generalize the findings, even though these new institutions did not participate in the administrations in 1997, 1999, or 2002.

Some of the original SUCCEED institutions did not participate in the 2014 administration because they were concerned about an interference with local efforts to assess faculty teaching practices and assessments relating to accreditation. This is a symptom of growing concern over assessment fatigue, particularly survey fatigue. Some universities have begun to centralize the approval of survey assessments administered to the academic community. A Survey Advisory Committee (SAC) at North Carolina State University was formed to "provide recommendations on policies and practices to govern surveys of members of the NC State campus community" (OIRP, 2014). This committee was formed to help protect the time and resources of the university's faculty, staff, students, and administrators.

Standard practices were used to improve survey response rates. The survey was emailed from someone within each of the institution's administration for it to be from a source that was credible (Dillman, 2007) and there were reminder emails sent out to faculty a couple weeks after the initial launch (Dillman, 2007; Kaplowitz, Hadlock, & Levine, 2004; Deutskens, et al., 2004). The survey was built to put similar items into groupings which decreased the overall amount of survey time (Couper, Traugott, & Lamias, 2001; Deutskens, et al., 2004) and there was a progress bar showing how much of the survey was left to help motivate participants to finish (Couper, et al., 2001; Dillman, et al., 1999). Despite all these efforts, there was a low response rate of about 10 percent because the survey was distributed through participant's work email addresses (Dillman, 2007; Klapowitz, et al., 2004; Deutskens, et al., 2004) nor was there any reward or lottery offered (Bosnjak & Tuten, 2003; Church, 1993; Deutskens, et al., 2004). In spite of these efforts, the compounding circumstances of a low survey response rate and non-participating institutions, the data collected were not well-suited to the original research questions. Nevertheless, the data collected, particularly the qualitative data collected from open-ended comments on the survey, made it possible to address questions of importance.

The remainder of this chapter describes the scope of the research, the significance of doing this study, and the statement of purpose. The research questions will show the clarity of purpose. The assumptions, limitations, delimitations, and definitions of key terms are also addressed.

1.2 Scope

This research proposal focuses on how faculty define quality teaching, the teaching methods they report using in the classroom, their views on accreditation and its effect on their teaching quality, and how institutional climate affects their teaching quality. The survey is a self-report by what faculty perceive in response to Likert-type questions and open-ended responses to prompts on surveys distributed electronically. This research does not include any observational component.

1.3 Significance

The significance of this study is new insight to the research community about the perceptions of faculty of teaching methods being used in the engineering classrooms, the perceptions of quality pedagogies from engineering faculty, and whether there has been any affect from the accreditation process or institutional climate for individual faculty's teaching quality.

There have been multiple calls for change in engineering education (American Society for Engineering Education, 2009; King, 2008; National Academy of Engineering, 2004; National Research Council, 2012; Shavelson & Towne, 2002; Streveler, Smith, & Miller, 2005; Streveler & Smith, 2006). There have been multiple multimillion dollar coalitions made across the United States to help this movement of changing the way we educate engineering students from the National Science Foundation (NSF) including SUCCEED, ECSEL, Gateway, and Foundation (Borrego, 2007). ABET is an accreditation board for applied science, computing, engineering, and engineering technology degree programs in

the United States (ABET, 2013). ABET changed the criteria for accrediting engineering degree programs between 1996 and 2004 to help stimulate and move engineering programs to adopt more of a student outcomes focus (Prados, Peterson, & Lattuca, 2005). The significance of this work is in exploring three significant influences on how faculty choose teaching methods—their definition of quality teaching, the teaching climate at their institution, and their views on accreditation and its effect on teaching quality.

Recalling that many faculty are aware of student-centered teaching methods but are not using them (Borrego, Froyd, Henderson, Cutler, Prince, 2013), it would be easy to think that those faculty members simply do not care about teaching. This research provides evidence that many faculty value teaching quality—but that their definition of quality leads them to focus on teacher-centered methods such as lecture. Recognizing the different perspectives of faculty can affect how administrators and department heads talk to their faculty about teaching quality. The findings of this research regarding faculty perspectives on ABET accreditation processes provide critical feedback both to ABET and to accreditation coordinators at the institution and program level—many faculty believe that the accreditation process as currently implemented is stifling. This research also describes the different language and experience characteristic of faculty members based on their teaching methods and the institutional climate for teaching quality. Identifying these patterns may help faculty understand their experience and may help institutions improve.

1.4 Definitions

The historical data from surveys administered in the SUCCEED Coalition in 1997, 1999, and 2002 used the term "quality teaching". Noting the potential ambiguity of this term, this research both collects faculty definitions of this term and subsequently provides a definition of that term to ask faculty to report on what influences quality teaching. Questions about ABET accreditation processes were added to the survey both because it was a significant potential source of changing influence in the time span studied and because the goal of ABET assurance of quality, and ABET's vision statement and goals mention "quality teaching". By adding questions about ABET, this research could explore the relationship between accreditation and quality teaching for faculty.

To explore faculty views on what influences quality teaching, it was necessary to provide a definition of quality teaching—after faculty had already provided their own definition. The definition of quality teaching in this research starts from student outcomes. The outcomes from active learning pedagogies range from deeper student learning to better retention because students enjoy the courses (Prince, 2004). The use of active (or, more generally, student-centered) pedagogies help retain all students, particularly women and minorities (Berry, 1991; Frederickson, 1998). Improving retention of women and minorities is a national imperative because it addresses workforce concerns, social justice issues, and has the potential to improve the profession by applying more diverse perspectives in the design process. Thus, the definition of quality teaching used in this research is based on the use of student-centered teaching methods.

The research questions that evolve to address the issues described above are below. Studying faculty definitions of quality teaching, their perspective on ABET accreditation processes, and the climate for teaching at their institution resulted in a dissertation in a three-paper format. Each paper includes a description of its research questions and the literature that shaped those research questions. The full set of research questions is presented here as an outline of the work.

1.5 Research Questions

Chapter 2: Engineering faculty perspectives on the nature of quality teaching

a. How do engineering faculty define quality teaching?
b. What influences faculty's definition of quality teaching?
c. How are a faculty member's influencers of quality teaching related to his/her pedagogical choices?

Chapter 3: The influence of ABET accreditation practices on faculty approaches to teaching

a. How do faculty describe the influence of the ABET accreditation process on quality teaching?
b. How do faculty definitions of quality teaching influence their views of the ABET accreditation process?
c. How are faculty perceptions of the ABET accreditation process related to faculty teaching practices

Chapter 4: Faculty perspectives and institutional climate for teaching quality in engineering

a. How did faculty describe the quality and importance of teaching on their campus?
b. How did those descriptions change over time?
c. How do faculty describe the effect of the teaching climate?
d. How does institutional climate effect faculty approaches to teaching?

1.6 Assumptions

One of the basic assumptions in this study is that faculty were honest and accurate, to the best of their ability, when answering survey questions. In particular, faculty must be accurate enough in their reporting to ensure a consistent and positive correlation between what faculty report and what is actually happening in the classroom. The magnitude of this correlation is less important. It is assumed that when faculty are asked in the survey about their definition of quality teaching, that they are writing about their beliefs about quality teaching and are not providing some sort of "expected" response. For this reason, the open-ended definition of quality teaching is the first question on the survey. To the extent that this research uses a survey with modest changes from a survey that has been published previously, some steps normally taken in survey development and validation have been omitted. The validity of the instrument relies on its prior peer review and publication. There is an assumption that the faculty will have enough awareness of teaching methods that the instrument has face validity. This study assumes that the faculty who have taught undergraduates in the past three years will be able to recall how they taught the students. The study focuses on undergraduate teaching, but acknowledges

that faculty may take a sabbatical, may not teach undergraduates every semester, or may have other reasons that keep them from teaching undergraduates in the terms studied. There is an assumption that faculty are familiar with the ABET criteria and can reflect on how this has impacted their teaching.

1.7 Limitations and Delimitations

The results are engineering faculty's perceptions of what is happening in the classroom, and not necessarily what is actually happening. Faculty may not be able to deconstruct how different influences (institutional, ABET, learning about new teaching practices, etc.) have affected their teaching practices. The survey response rate was around 10 percent. The institutions used in this study were all large, public, four year institutions. The views expressed in the open-ended responses could be the faculty with the extreme views that felt compelled to answer, and there may be missing data from faculty that do not have strong feelings about the topics covered in this survey.

As is typically the case, the design of the study and the data collected result in various delimitations or bounds on the scope of the work and its interpretation. The quantitative components of this work do not represent a cross-section of all engineering faculty in the United States. The results represent those faculty at the colleges in the study. Further, this study cannot identify individuals longitudinally. This research does not disaggregate results according to the use of specific student-centered teaching methods. Specific active learning strategies such as collaborative and cooperative learning have been studied previously, but are not differentiated in this study.

Where this study relies on qualitative methods, generalization is not the goal—rather, the goal is to understand and interpret the influences on teaching practices from the viewpoint of faculty. While the qualitative data source includes rich and often extensive comments, the comments as qualitative data do not represent a dialogue between the participant and the researcher—the communication is one-way. There was no way to contact the faculty that responded to the survey because the researchers assured anonymity to the participants and to the Institutional Review Board (IRB) of all survey participants, thus the survey did not collect specific identifiable information. This made the comments in the open-ended questions a statement with no way to follow-up or ask faculty to clarify their meaning.

CHAPTER 2. ENGINEERING FACULTY PERSPECTIVES ON THE NATURE OF QUALITY TEACHING

2.1 Introduction

There have been multiple calls for change in higher education, these changes are calling for more student-centered teaching practices: From Analysis to Action (NRC, 1996), Shaping the Future (NSF, 1996), and Transforming Undergraduate Education in Science, Mathematics, Engineering, and Technology (NRC, 1999). Research has shown student-centered (nontraditional) teaching has advantages of higher retention, deeper learning, and student enjoyment (Astin, 1993; Cabrera, Nora, Bernal, Terenzini, & Pascarella, 1998; Cooper, 1990, Gamson, 1994; Goodsell, Maher, & Tinto, 1992; Kulik, Kulik, & Cohen, 1979; Levine & Levine, 1991; McKeachie, 1986; McKeachie, 1990; Murray, 1998; Pascarella & Terenzini, 1991; Prince, 2004). There have been multiple studies showing that engineering faculty have not adopted student-centered teaching methods, the intrinsic and extrinsic barriers that preclude them from adopting student-centered teaching methods (Borrego, Froyd, Henderson, Culter, Prince, 2013; Prince, 2004; Riley, 2003; Smith, Douglas, Cox, 2009; Smith, Sheppard, Johnson, & Johnson, 2005; Wankat & Oreovicz, 1993). A recent report showed that engineering faculty were the third lowest in higher education, at 45.5 percent, to ask the students to think critically about the deeper meaning or significance of what they were learning (Eagan, Stolzenberg, Berdan Lozano, Aragon, Suchard, & Hurtado, 2014). This research wanted to understand the intrinsic

barriers to adopting student-centered (nontraditional) teaching methods. One way to find out what was going on inside faculty's heads was to ask them to define quality teaching. This is what this research did, asked faculty to define quality teaching, and through this study, the nature of quality teaching was discovered. This research was able to get to the essence of what engineering faculty thought about quality teaching.

The purpose of this study was to discover the nature of quality teaching within engineering faculty at a number of universities within the United States. A wide variety of stakeholders would likely agree that quality matters in higher education—but what does that mean? The definition of "quality" is likely to vary from person to person and even for the same person as the context changes. Measuring the quality of an automobile is different from measuring the quality of drinking water. The purpose of this research was to explore the different definitions of quality teaching in engineering education from the perspective of faculty. To the extent that engineering faculty are typical of other faculty in higher education, in that they receive minimal, if any, formal training in teaching (Kenny, et al., 2001), the findings here should have relevance to other disciplines.

This research will help faculty, faculty developers, administrators, students, and industry leaders understand the language used to describe quality teaching and the criteria faculty are using to define it. Thus, this papers leads to a deeper understanding of quality teaching in engineering education—an essential step in achieving it.

This research is important for another reason. If there is diversity in how faculty define quality teaching, but the evaluation of teaching does not acknowledge that diversity, the result is that the success of some faculty who are striving for quality teaching will be measured against the wrong yardstick. As we strive for more diversity in engineering among students and faculty, and in the profession more generally (NAE, 2002), we must be transparent in how we measure success and we must measure success in different forms.

2.2 Literature Review

This research is about the nature of quality in teaching engineering. The nature of quality digs deeper than finding specific criteria for a quality management tool. Nature, by definition is the "inherent character or basic constitution of a person or thing: essence" as this research has gotten to the essence of quality teaching according to engineering faculty (Merriam-Webster, 2014). The nature of quality looks at the different perspectives of quality and what these perspectives are looking for when they seek quality.

Research on quality management in higher education. There is a substantial research base on quality and quality management in industry. Those methods have been applied toward designing a quality management system for higher education as well, with a variety of papers on different topics within the umbrella term of "quality" (Srikanthan & Dalrymple, 2003). Owlia and Aspinwall (1996) created a framework for dimensions of quality specifically for colleges and universities by comparing nine different models of

service quality dimensions. Each of the nine different models that were compared showed how different perspectives can change the models quality dimensions. Owlia and Aspinwall (1996) compiled all these different service quality dimensions into one they developed for higher education: tangibles, competence, attitude, content, delivery, and reliability; and the authors mapped each dimension to the customers, which students were in each one, staff were added in tangibles, competence, content, and reliability, and employers were added into the quality dimensions of content and reliability. Even in these papers, there is debate of how to assess the teacher-student interactions because envisioning a student as a metaphorical "output" of a manufacturing process is unpalatable. Another approach to measuring quality in higher education is based on methods of measuring quality in a service business, because this avoids the need to compare students to products being developed and made in a factory (Owlia & Aspinwall, 1996).

Research looking at quality from five perspectives. The work of Garvin (1988) move in a useful direction for our work, because he provides a five-faceted definition of quality: transcendent, product-based, user-based, manufacturing-based, and value-based. By encompassing a diversity of meanings of quality, we begin to be able to account for the different ways faculty achieve it. Transcendent interpretations of quality are individualistic, personal, and associated with ideas like love. Product-based interpretations are based on measurable standards. User-based interpretations address customer satisfaction criteria, which may vary considerably among stakeholder groups.

Manufacturing-based interpretations are those that emphasize zero-defects based on manufacturer specifications. Value-based interpretations focus on economic benefit. Harvey and Green (1993) adapted Garvin's definitions of quality in higher education resulting in five similar categories: exceptionality (in the sense of excellence), perfection and consistency, fitness for purpose, value for money, and transforming. These definitions, described below, of the nature of quality fit the data from how engineering faculty described quality teaching.

Higher education quality as exceptional. Exceptionality is accepted universally in higher education because it is so elite and rare (Pfeffer & Coote, 1991). This definition is pervasive in higher education because it is viewed as distinctive, special, or high class (Astin, 1993; Harvey & Green, 1993). Astin (1993) described the typical values behind excellence in education as reputation and resources, whereas he argued for "talent development", focused more directly on the basic purpose of higher education. In resources, Astin included money, high-quality faculty, and high-quality students. Astin described reputation as a pyramid with a few well-known universities on top and two-year community colleges and most smaller four-year universities on the bottom with no systematic research justifying an institution's position in the pyramid.

By defining quality as exceptionality, it becomes conflated with exclusivity, inaccessibility, and privilege. Higher education in general is thus granted a measure of quality simply because not all people participate. Universities in particular establish quality by being exceptional in certain ways among institutions of higher education.

Thus, Astin (1993) describes an American folklore of reputation in higher education. Ball (1985) defined excellence as having high, almost unattainable, standards. Meeting such standards requires excellent inputs and outputs (Moodie, 1986), which would make access to higher education even more limited. Ironically this focus on attracting exceptional students reduces the need for quality teaching—as Harvey and Green note, "It does not matter that teaching may be unexceptional—the knowledge is there, it can be assimilated." (1993, p. 12, italics added for emphasis). This view of quality has been described in universities in Britain, Germany, and the United States (Astin & Solomon, 1981; Frackmann, 1991; Moodie, 1988; Miller, 1990).

Perfection and consistency as quality in higher education. Harvey and Green's (1993) description of perfection and consistency as quality is an educational implementation of "zero defects" and "getting things right the first time". This form of quality is more inclusive because it is possible for all institutions to achieve rather than being marked by exclusivity. An institution can demonstrate quality by meeting predefined measurable standards. The focus is on the process and conformance to specifications, but this definition of quality embodies a philosophy of prevention in which all educators are responsible for quality rather than stressing inspection as a means to quality (Peters & Waterman, 1982). This echoes Deming's principle, "Cease dependence on inspection to achieve quality" (Deming, 1986) and more recently, ABET's policy that "It is not necessary to assess the level of attainment of an outcome for every graduate. Similarly, it is not necessary to assess the level of attainment for an outcome every year. Appropriate

statistical sampling procedures may be used in the assessment of outcomes and objectives." (ABET, 2014).

Higher education's fitness for purpose. Fitness for purpose provides another approach to defining quality, which resonates with both our desire to recognize a diversity of goals faculty might work toward and with the diversity of institutional missions. While Harvey and Green (1993) define fitness for purpose as how well the service meets the expectations of the customer, there is no clear agreement on who the customers are in the case of higher education. Some customers that have been associated with higher education are students, parents, industry, and taxpayers (Jauch & Orwig, 1997; Mazelan, 1991). While students may be considered consumers of education because they enter the institution and are educated. Employers also consume that education by hiring the graduates and purchasing research services (Collins, Cockburn, & MacRobert, 1990; Harvey & Green, 1993). In the case of higher education, there is also concern that customers are not in the best position to know what the specifications should be, particularly if the students are viewed as the customers (Marchese, 1991; Roberts & Higgins, 1992). If we consider the institutional mission as fitness for purpose, the institution can be judged by how effectively and efficiently it achieves its mission, based on the quality assurance mechanism the university has in place (Harvey & Green, 1993). Since the mission and its quality assurance mechanism may not align with consumers and their view of quality, customer satisfaction should be considered. Nevertheless, students satisfaction may not align with other measures of quality (Sallis & Hingley, 1991).

Value for money in higher education. Harvey and Green's fourth definition is "value for money". This interpretation assumes that quality can be defined in economic terms. This approach levels the playing field of exceptionality by considering what an institution achieves with the students it attracts and the resources it consumes. In higher education within the United States, research expenditures are one of the primary measures of quality (Jennings, 1989; Cross, Wiggins, & Hutchings, 1990; Hutchings & Marchese, 1990; Millard, 1991). Measures of efficiency may not be good measures of effectiveness (Yorke, 1991). Sensicle (1991) points out that there may be a tendency to rely solely on performance indicators to measure quality, and writes, "important qualitative aspects of performance and progress in higher education might be missed or submerged" (p. 16). Harvey and Green (1993) have suggested customer charters as a way to establish a set of standards of what a customer should expect for the money they pay, thus establishing a measure of quality. While such charters are intended to create a competitive market for higher quality, they have more commonly been used to set a standard practice for maintaining quality.

Transformation as quality in higher education. The final category for quality is transformation. Transformation is a change of form, which can be documented qualitatively (Harvey & Green, 1993). Harvey and Green give an example of ice being transformed into water, where the temperature can be documented quantitatively, but the form change from solid to liquid can be documented qualitatively. In regards to education, the transformation process can be applied as doing something to the consumer,

rather than doing something for the consumer (Elton, 1992). This transformational idea of higher education even applies to the construction of new knowledge, because we are not just adding to the research, but are intertwined within the research we study (Kuhn, 2012; Price, 1963; Lakatos & Musgrave, 1970; Mullins, 1973; Holten, 1988). There are two different perspectives of looking at transformation within education, enhancing and empowering the consumer. Enhancing the consumer or the consumer's value added is hard to measure because what, exactly, is being measured? This can be related back to the inputs and outputs from the previous quality categories because with a value added, the conclusion would be to find a way to measure the value added, and perhaps miss the qualitative nature of quality added. Muller and Funnell (1992) argue for transformation in value added by explaining that learners should be participants in their own learning and evaluating processes. This is closely aligned with empowering the consumer, which involves giving power over to the consumer to transform (Harvey & Burrows, 1992). Empowering the student in higher education will give them a chance to make decisions on their own learning (Wiggins, 1990). This self-empowerment can lead to student evaluations, student charters, self-selecting classes and their critical thinking ability (Harvey & Green, 1993). The critical thinking cannot be learned through traditional lecture style teaching: "This requires an approach to teaching and learning that goes beyond requiring students to learn a body of knowledge and be able to apply it analytically. Critical thinking is about encouraging students to challenge preconceptions; their own, their peers and their teachers." (Harvey & Green, 1993, p. 26). Quality in terms of transformation of students is seen as "the extent to which the education system

transforms the conceptual ability and self-awareness of the student." (Harvey & Green, 1993, p. 26).

These definitions the nature of quality in higher education were a natural fit to use as a context for the definitions of quality teaching given by engineering faculty because it fills a gap of what faculty are self-reporting what they are doing in the classroom and what they actually believe is quality teaching. The research was set as a survey of self-reported teaching methods being used in the classroom, which may not tell the whole story of the faculty's attitude about quality teaching, unless we asked them about their attitude toward teaching. When the researchers asked faculty to give a definition of quality teaching, this gave better insight as to the nature of faculty's beliefs about teaching and what their underlying assumptions are about different teaching methods, like traditional and nontraditional teaching. By classifying engineering faculty based on their definitions of quality teaching, the researchers were able to get to deeper assumptions about teaching that engineering faculty have. There have not been any other studies that address the nature of quality teaching in engineering that the researchers have been able to uncover.

2.3 Methods

This work builds on a survey administered to faculty at institutions in the SUCCEED Coalition in 1997, 1999, and 2002 (Brent, Felder, Brawner, Miller, & Allen, 1998; Brawner, Felder, Brent, Miller, & Allen, 1999; Brawner, Felder, Allen, & Brent, 2001; Brawner, Felder, Allen, & Brent, 2001; Brawner, Felder, Allen, & Brent, 2002; Brawner, Felder, Brent, & Allen, 2004). Just as the 1999 and 2002 surveys included minor updates

based on changes in educational technology since prior survey administrations, changes were made to update the 2014 survey to reflect current technology. The original study design was to use successive independent samples to explore changes at those institutions in the past 12 years—changes in teaching methods, changes in the value of teaching, and changes in the influence of various other stakeholders on faculty teaching practice. Additional questions were added to specifically probe faculty perspectives on quality teaching and on the effect of the accreditation process on teaching practice. In an effort to further generalize the findings from this study as well as some of the findings from the earlier survey administrations, additional institutions were invited to participate in the survey, even though those new institutions would not have comparison data from earlier administrations.

Some institutions that had administered the faculty teaching practices surveys in 1997, 1999, and 2002 did not participate in the 2014 administration. The most common reason was concern for an escalation of survey administration, particularly in cases where it was believed that administering the survey would interfere with local efforts—in two cases, assessments related to accreditation, and in another case, an independent effort to assess faculty teaching practices.

The culture of engineering education has an emphasis on assessment and continuous improvement – more generally because the profession is self-managing, and particularly because of the accreditation processes itself. Nevertheless, concerns for assessment fatigue—survey fatigue in particular—are growing. North Carolina State University has

charged a Survey Advisory Committee (SAC) "to provide recommendations on policies and practices to govern surveys of members of the NC State campus community" (OIRP, 2014). While this committee was formed in part to protect the time and resources of the NC State community (students, faculty, staff, administrators, and alumni), it also arises out of concern that survey fatigue is leading to declining response rates and, ultimately, less robust data collection.

The choice of multiple institutions in our target population to decline participation (which was not expected) was compounded by a low survey response rate. We made efforts to improve the response rate, such as having the survey invitation come from a credible source (Dillman, 2007), sending reminder messages non-respondents (Dillman, 2007; Kaplowitz, Hadlock, & Levine, 2004; Deutskens, et al., 2004), grouping like items together to decrease survey time (Couper, Traugott, & Lamias, 2001; Deutskens, et al., 2004), and motivating participants to continue by branching to reduce overall survey length and displaying a progress indicator (Couper, et al., 2001; Dillman, et al., 1999). In spite of these measures, a low response rate was anticipated because the survey was distributed electronically (Dillman, 2007; Klapowitz, et al., 2004; Deutskens, et al., 2004), because we could not offer an incentive (Bosnjak & Tuten, 2003; Church, 1993; Deutskens, et al., 2004), and for the reasons cited given above (OIRP, 2014). The low participation by target institutions and faculty within the institutions that did distribute the survey resulted in a shift in the research design and a concomitant increase in the importance of the questions that were added to the survey.

This work focuses on findings from an open-ended question, “How do you define quality teaching?” and five follow-up questions that measure the influence on quality teaching of (a) the ABET accreditation process, (b) colleagues, (c) department climate, (d) the promotion and tenure process, and (e) personal commitment to students. These follow-up questions were measured on a Likert-type scale from 1 (extremely negatively) to 7 (extremely positively). The other notable addition to the survey was an open-ended question and multiple follow-up questions related to the influence of accreditation. The results from those questions are beyond the scope of this paper.

The open-ended responses defining quality teaching provided the basis for a collective case study (Stake, 1998) of how faculty define quality and what influences that definition. Among 91 survey respondents, 82 provided definitions of quality teaching. The definitions were read multiple times and each definition was associated with a particular definition of quality described by Harvey and Green (1993). While some responses included a combination of phrases that might be associated with multiple definitions, it was possible to associate all responses with a dominant definition.

Logistic regression was used to explore the extent to which the various influences determine a faculty member’s definition of quality, and the Duncan-Waller test for multiple comparisons was used to examine the relative importance of the five influences. Correlations of the five influencing factors are also discussed.

Considering the quality of the qualitative data (Walther, et.al., 2013), the theoretical validation of this data, while limited by including participants only from large, public, research institutions, other modes of variation are present. The perspective of those of different ranks and positions is included, consistent with an average engineering department. The average amount of time teaching was 16 years, which would indicate that we are not measuring novelty effects. Procedural validation was shown through the use of qualitative and quantitative data to triangulate the results. Further, the constant comparative method was used to make sure that the researchers were staying consistent with coding the definitions of quality teaching (Walther, et. al., 2013). Communicative validation was not present because this data used an open-ended survey, thus there was only one way communication, but this enhanced process reliability through the use of a consistent survey message given to all the universities with the exact same survey (Walther, et. al, 2013).

2.4 Results and Discussion

Survey response rates. The response rate for each university separated by faculty type is shown in Table 2.1. The response rates fluctuate some, but do not raise concerns that the results will be particularly biased toward one institution or faculty type. It does impose limitations on our ability to disaggregate by both variables simultaneously in our findings, but such an analysis is precluded by our low sample size in any event.

Table 2.1: Response rates by participating institution and faculty type

	Tenure/tenure track	Non-tenure track
School	% reported	% reported
A	8%	6%
B	11%	12%
C	9%	6%
D	3%	8%
TOTAL:	8%	10%

The gender distribution of responses from each institution is shown in Table 2.2. Compared to the representation of women among engineering faculty, this represents a higher response rate for women, which is not uncommon (Smith, 2008). Studies of survey response rates show that gender is the single greatest predictor of survey completion (Sax, Gilmartain, & Bryant, 2003). This overrepresentation of women faculty is a limitation in the limited modeling included in the current study, but oversampling women faculty, though unintentional, is an asset to the collective case study.

Table 2.2: Gender distribution of response rates by participating institution

School	Male	Female	Not Reported
A	63%	25%	13%
B	68%	32%	0%
C	71%	14%	14%
D	67%	33%	0%
Total:	67%	25%	8%

Responses spanned a range of faculty ranks, as shown in Table 2.3. The first question on the survey was if faculty have taught undergraduates in the past three years, and there were 97 responses to this question, where 5 faculty said they had not taught

undergraduates in the past three years. The faculty that reported teaching undergraduates in the past three years were asked to answer all the questions of the survey, faculty that had not taught in the past three years were taken to the end of the survey without being asked any other questions. Respondents averaged 16 years as a faculty member, 13 of which were at their present institution. Respondents were affiliated with various disciplines, with the larger disciplines of Mechanical Engineering, Electrical Engineering, and Civil Engineering most represented. Disaggregation by discipline is not possible with the data collected.

Table 2.3: Distribution of responses by faculty rank.

Assistant Professor	Associate Professor	Professor	Instructor/ Lecturer	Faculty of Practice	Adjunct/Visiting (any rank)	Emeritus/ Retired	Other
17%	26%	34%	15%	1%	2%	0%	4%

Quality teaching as exceptionality. Harvey and Green's definition of quality as exceptionality was the most common. Some of the typical expressions in definitions classified in this category referred to "knowledge transfer" and "knowing content knowledge". These represent a view of teaching in which students are vessels into which the professor's knowledge is poured. The student is a passive participant in the classroom (Harvey &Green, 1993). Harvey and Green describe this approach: "It does not matter that teaching may be unexceptional—the knowledge is there, it can be assimilated." (1993, p. 12). Faculty adopting this definition articulated the passive role of students in various ways—most delineating the measure of quality teaching from the instructor's perspective rather than the student's as "the effectiveness by which the material taught is

conveyed from instructor to student" (#39) and "the ability to convey information to non-experts" (#40). A more extreme expression of this instructor-centered paradigm overtly disregards the student experience as important: "class does not have to be 'fun' or even interesting…" (#36). Nearly half (43 percent) of faculty had a definition of quality teaching that fit this category.

Quality teaching as transformation. Faculty whose definition of quality teaching focuses on the transformation of students use much more developmental language, describing the changes students experience as enhancing and empowering them to transform (Harvey & Green, 1993). This was the second most prevalent definition of quality teaching, with 28 percent of faculty definitions fitting this category. Such faculty discourse also tended to be more focused on process than content, describing the importance of "empowering students," "developing students," and "creating an environment for learning", and referring to pedagogies of engagement such as "active learning." One faculty described this process focus as, "effectively engaging students in the work of the course and empowering them to take responsibility for their learning and the learning of their peers." (#71) This shift in responsibility for learning to students and their peers can also represent a loss of control for the faculty. Harvey and Burrows (1992, p. 3) write, "it embodies not just a loss of control over the structural organization or academic content of higher education; it is a loss of control over the intellectual processes." The tension involved in adopting a transformational definition was articulated by a faculty member who struggled "…to find a balance between two conflicting roles:

that of a coach, and that of a judge/gatekeeper… to identify and emphasize conceptual material that is non-intuitive." (#33).

Wiggins argues that "we have a moral obligation to disturb students intellectually. It is too easy nowadays, I think, to come to college and leave one's prejudices and deeper habits of mind and assumptions unexamined—and be left with the impression that assessment is merely another form of jumping through hoops or licensure in a technical trade" (1990, p. 20). Engineers need to know technical knowledge and be able to question deeper assumptions. Yet even among engineering faculty who adopted this definition, some expressed concerns that engineering has technical knowledge requirements and that giving up control of student learning may leave students without all the tools they need to be a successful engineer. Other faculty were committed to student transformation without reservation, contrasting their views with the dominant "exceptionality" approach: "A course should ideally develop in the student a new way of thinking or a new perspective/lens into the world. Just exposure to new information or even a new skillset is not indicative of a high quality course." (#38).

Quality teaching as fitness for purpose. This definition was characterized by terms such as "ability to meet specific legitimate learning objectives" and "mastery of learning outcomes." This category was nearly as prevalent as transformation, with 24 percent of faculty definitions coded as being in this category. Many faculty in this category used the term learning objectives and outcomes more generally, such as, "establish clear learning outcomes for the course and providing meaningful learning opportunities that foster

mastery of the outcomes" (#84) and "students attain learning outcomes en masse..." (#90). In those cases, it is unclear if those learning outcomes are chosen by individual faculty or the department, college, or university. Similarly, these general descriptions are unclear as to what those learning objectives are and whether certain outcomes are more important than others to the faculty member.

Although faculty did not generally name the specific learning objectives or outcomes tied to a course, some were more specific about the "purpose" of the learning outcomes. Some faculty identified the "purpose" as application to practice, such as "How well the students can retain knowledge in the future and how well students are able to apply what they've learned in the future" (#42) and "teaching the topics which are important to the students' future success…" (#66). Faculty that define quality teaching in consideration of the student's future attempt to frame quality from the perspective of the student. This aspect of "fitness of purpose" is called "quality in perception" (Harvey & Green, 1993, p.20; Sallis & Hingley, 1991).

The definitions of quality teaching that fit in the "fitness for purpose" category are vague and varied because there is uncertainty and variation in defining the "purpose" of higher education in general and engineering in particular. There are many stakeholders in engineering education with diverse perspectives.

Quality teaching as perfection and consistency. The definitions of quality teaching received in this study did not resonate with this "zero defects" category. One respondent

stressed "clarity and consistency in grading procedures" (#89), and was coded as having this definition. Srikanthan and Dalrymple (2003) focused on the stakeholders in higher education and expected that employees such as faculty and administrators would view quality in this category, but we do not find this to be the case in our sample.

Quality teaching as value for money. No respondents specifically addressed financial value, return on investment, specific performance indicators, or student/teacher charters on criteria for teaching—all characteristics that would be coded in this category based on Harvey and Green's description. One respondent's definition was classified in this category who cited ABET as an external authority. Turning to an entity outside the university to set standards of quality is also characteristic of this definition. This respondent's definition of quality teaching included "facilitating student learning of the specific technical and non-technical (includes ABET a-k) information and skills that apply to the course in question" (#13).

Influences on quality teaching. The relationship of the five influences to a respondent's definition of quality was studied using logistic regression, with the definition of quality teaching as a categorical outcome variable and the five influences as independent variables. Neither gender nor faculty rank was found to play a role in a faculty member's definition of quality teaching or the nature or extent of influences on teaching quality, so those were removed from the model and are not discussed further.

Table 2.4: Means of each of the influences by quality.

Nature of Quality	ABET	Colleagues	Department Climate	Tenure & Promotion	Personal Commitment
None	4.1	5.5	5.1	3.8	6.4
Exceptional	3.9	5.1	4.6	3.9	6.6
Perfection	4.0	4.0	2.0	3.0	6.0
Fitness for Purpose	4.6	5.7	5.1	3.8	6.7
Value for Money	5.0	4.0	4.0	3.0	6.0
Transformational	4.0	5.6	4.8	4.0	6.7

Table 2.5: Means of each of the influences by gender.

Gender	ABET	Colleagues	Department Climate	Tenure & Promotion	Personal Commitment
Not Reported	3.0	6.0	5.9	3.9	6.9
Male	4.1	5.3	4.5	3.8	6.6
Female	4.5	5.7	5.5	4.1	6.3

Table 2.6: Means of each of the influences by university.

University	ABET	Colleagues	Department Climate	Tenure & Promotion	Personal Commitment
A	4.2	5.4	4.6	3.8	6.2
B	4.3	5.6	4.8	3.8	6.8
C	3.9	4.8	4.5	4.2	6.7
D	4.0	6.2	5.8	4.0	6.8

Table 2.7: Means of each of the influences by rank.

Rank	ABET	Colleagues	Department Climate	Tenure & Promotion	Personal Commitment
Assistant	4.0	5.2	4.8	3.8	6.6
Associate	4.2	5.3	4.5	3.9	6.5
Professor	3.9	5.4	4.8	3.8	6.7
Instructor	4.5	5.6	4.9	4.0	6.2

Only one influence was found to have a significant (p=0.05) relationship to a respondent's definition of quality. With an odds ratio of 1.745, an increase of one unit on the reported influence of ABET accreditation is associated with a respondent being 1.745 times more likely to define quality teaching as "fitness for purpose." Because engineering accreditation provides a standard set of outcomes for engineering graduates (a common purpose), but provides flexibility in how those outcomes are achieved, this relationship can be explained. The greater challenge is explaining why no other relationships were observed between a respondent's definition of quality teaching and the various influences. Whereas a faculty member's definition of quality teaching was generally independent of their reported influence of the five factors studied, a pattern was observed among respondent's reported influences—there appeared to be a consistent ranking of the influences. To control for the effect of comparing multiple means, the Duncan-Waller test for multiple comparisons was used, and the results are shown in Table 2.8.

Table 2.8: Duncan-Waller test for multiple comparisons of influences on teaching quality

Duncan Grouping	**Mean**	**Influence**
A	6.6	Personal commitment to students
B	5.4	Colleagues
C	4.8	Departmental climate
	4.1	ABET accreditation
D	3.8	The promotion and tenure process

Note: means with the same letter are not significantly different (p=0.05), N=90 or 91.

Personal commitment to students has significantly more reported influence than colleagues, who have significantly more reported influence than the departmental climate, which in turn has significantly more reported influence than ABET accreditation and the promotion and tenure process. The promotion and tenure process is a ritual that formalizes some aspects of the department climate, but respondents draw a distinction between the two. In other words, colleagues and the department can communicate values and practices related to quality teaching that are not embodied in the promotion and tenure process—policies are slower to change than people.

It is discouraging to note that the average influence of the promotion and tenure process is negative—the promotion and tenure process—its focus on research grants and publications at these universities based on the open-ended responses of faculty—has a negative effect on faculty's teaching quality. Another survey, from COACHE, had

specific data for Purdue University that showed faculty are unsatisfied with the lack of clarity in the tenure process (McClure, 2012).

The ranking of the five influences studied was robust—the ranking was the same regardless of gender, faculty rank, and university. This has implications for faculty development practices. The strong influence of colleagues may at first appear to be a barrier to change—because even if a department has expectations regarding quality teaching (such as by requiring faculty to attend teaching workshops), a junior faculty member may reduce her or his commitment to quality teaching based on conversations with colleagues. Yet this influence represents an opportunity as well—this underscores the potential for positive influence through mentoring by colleagues—particularly where a teaching mentor is identified independently from a research mentor. Furthermore, the influence of colleagues suggests strategies for faculty development professionals; pairing senior and junior colleagues as they engage in faculty development related to teaching may be effective.

One university had a notably higher rating for the influence of the promotion and tenure process, so there is hope that a university's policies on promotion and tenure can have a positive effect on faculty's teaching quality. Respondents at that university also indicated a higher influence from colleagues (p=0.05, odds ratio = 0.37), so all other things being equal, respondents at that university rate the influence of colleagues 0.37 higher on average than at other universities in the sample.

Based on the consistency of the rank-order of the five influences, it is not surprising that responses for some of the influences are significantly correlated. Specifically, there is a relationship between the influence of colleagues and department climate (r=0.67, $p<0.0001$), department climate and the promotion and tenure process (r=0.33, $p<0.01$), and colleagues and personal commitment to students (r=0.28, $p<0.05$). These correlations neither provide additional insight nor diminish the meaningfulness of the earlier results.

Faculty's reported influencers are related to their teaching practices. As a measure of how the influencers are related to faculty approaches to undergraduate teaching, faculty were asked to describe the influence of the ABET accreditation process, their colleagues, the department climate, the promotion and tenure process, and their personal commitment to students on their teaching quality.

Responses to "ABET accreditation process" as an influence in teaching quality are unrelated to gender, total years as a professor, and institution. Using "Extremely negatively" (1) as the referent, faculty who responded more positively were less likely to "give students the option of working in teams (2 or more) to complete homework" [b = -0.41, χ^2 (1, N = 89) = 6.24, $p < 0.05$ (odds ratio = 0.665)]. This is an interesting finding, since ABET accreditation wants students to be able to work in teams as an outcome. This research has shown that faculty with a nature of quality of fitness for purpose are more likely to see the benefit of ABET accreditation standards, perhaps these faculty are focused on fitness for purpose, and do not see the purpose in giving students the option of working in teams.

Responses to "Colleagues" as an influence in teaching quality are unrelated to gender, total years as a professor, and institution. Using "Somewhat negative" (2) as the referent group because none of the participants marked colleagues as a one, faculty who responded more positively were more likely to "REQUIRE students to work in teams (2 or more) to complete homework" [$b = 0.36$, χ^2 (1, $N = 89$) = 4.26, $p < 0.05$ (odds ratio = 1.429)].

"Department climate" responses as an influence in teaching quality are unrelated to gender, total years as a professor, and institution. Using "Extremely negatively" (1) as the referent group , faculty who responded more positively were more likely to "REQUIRE students to work in teams (2 or more) to complete homework" [$b = 0.40$, χ^2 (1, $N = 88$) = 5.42, $p < 0.05$ (odds ratio = 1.488)].

The influencers of "promotion and tenure process" and "personal commitment to students" did not have any teaching methods that were statistically significant.

2.5 Conclusions

Engineering faculty do not have a common view of quality teaching. In this study, only three of five definitions of quality identified by Harvey and Green (1993) are prevalent. It is important for faculty developers and department chairs to recognize that faculty have different views of the nature of quality teaching because this will affect the goals they are trying to achieve and the extent to which various approaches to faculty development will resonate with those goals. It may help department chairs to know that certain faculty have

a definition of quality teaching that resonates with accreditation, because those faculty may be useful both in explaining the accreditation process to colleagues and in sharing the accomplishments of other colleagues with accrediting bodies. This is especially important in that faculty who view quality as exceptionality are likely to view accreditation processes as a waste of time and money. Department chairs and upper administration may also be interested in faculty that view the nature of quality as transformational because those faculty are more likely to see the benefit student-centered teaching techniques, which help institutions with recruitment and retention (Astin, 1993; Cabrera, Nora, Bernal, Terenzini, & Pascarella, 1998; Cooper, 1990, Gamson, 1994; Goodsell, 1992; Johnson, Johnson, & Smith, 1991; Kulik, Kulik, & Cohen, 1979; Levine & Levine, 1991; McKeachie, 1986; McKeachie, 1990; Murray, 1998; Pascarella & Terenzini, 1991; Prince, 2004). These faculty with a transformational definition of quality teaching may be best suited to "master teacher" roles to help other faculty see the value of this definition.

Faculty developers could use this research to help faculty identify with one of the perceptions of the nature of quality, which may help faculty understand the different perceptions and come to understand diverse perspectives of quality and better understand their colleagues. The two perceptions of the nature of quality that were not represented in this research was another finding, perfection and consistency and value for money. The researchers thought that some engineering faculty would see teaching engineering principles as perfection and consistency because of the exact nature of engineering work (seeing things as right and wrong) or value for money because the cost of education is a

topic of national discussion. Some recommendations for faculty developers is to use this information to address the specific needs of faculty with exceptionality value of quality teaching by explaining the research on how students learn and the best teaching practices from that research. Faculty with the transformative value of quality teaching could use more focused training on specific teaching methods. The fitness for purpose faculty could use a combination of an explanation of the research, which would show the purpose of specific teaching methods, and then a how-to workshop on student-centered teaching methods.

Future research should look at the link of faculty teaching practices and faculty's perception of the nature of quality. Departmental climate may also influence or be related to faculty's perception of the nature of quality, which was outside the scope of this work. The data used for this research was a small sample because of the low rate of participation from four universities. The two natures of quality definitions that were not popular in this sample (Perfection and Consistency and Value for Money). These perspectives might be represented in a larger sample, either from adding more institutions or getting more faculty to participate.

CHAPTER 3. THE INFLUENCE OF ABET ACCREDITATION PRACTICES ON FACULTY APPROACHES TO TEACHING

3.1 Introduction

Engineering programs in the United States are accredited by the Engineering Accreditation Commission of ABET (ABET, 2013a). ABET also accredits engineering programs in other countries upon request (ABET, 2013b). ABET's Criteria for Accrediting Engineering Programs (ABET, 2013c) were revised in the 1990s because engineering educators perceived the criteria standards limited innovation in engineering degree programs (Daniels, Wood, & Kemnitzer, 2011). This research project explores the effect ABET has on faculty teaching practices. Faculty were surveyed about their views on ABET's focus on student outcomes and about their approach to teaching, and relationships between the two have been identified.

The "Engage to Excel" report (Olson & Riordan, 2012) claims that the United States needs one million more college graduates in science, technology, engineering, and mathematics. One way to get more college graduates in STEM is to teach differently, because it has been shown that STEM (traditional) teaching is one of the major reasons that students leave these degree programs (Seymour, 2002). Quality teaching is even more important because it can keep the students that enrolled in STEM degrees and could attract more diverse students into these degrees.

3.2 Literature Review

ABET accreditation and its fit with definitions of quality. ABET was founded in 1932 as a way to bring together professional organizations for applied science, computing, engineering, and engineering technology programs (ABET, 2014d). ABET's vision states: "ABET is recognized as the worldwide leader in assuring quality and stimulating innovation in applied science, computing, engineering, and engineering technology education." (ABET, 2014d). ABET's mission statement provides additional detail about quality, innovation, development, and advancement of education:

"ABET serves the public globally through the promotion and advancement of education in applied science, computing, engineering, and engineering technology. ABET:

- Accredits educational programs.
- Promotes quality and innovation in education.
- Consults and assists in the development and advancement of education worldwide.
- Communicates and collaborates with its constituents and the public.
- Anticipates and prepares for the changing educational environment and the future needs of its constituents.
- Manages its operations and resources in an effective and fiscally responsible manner." (ABET, 2014d)

Noting the priority of *assuring quality* in engineering degree programs as expressed in ABET's vision and mission, we anticipate there will be various faculty responses to the accreditation process, because quality is a subjective term and can have very different meanings to faculty, administrators in higher education, industry, students, and other

stakeholders. Earlier work has described variation in how faculty define quality teaching (McNeil & Ohland, 2014).

Much of the research on quality in engineering focuses on creating quality assurance mechanisms or dimensions akin to industrial engineering quality management for factories or product development (Owlia & Aspinwall, 1996; Srikanthan & Dalrymple, 2003), yet some researchers have considered the subject of quality in higher education. Harvey and Green (1993) identified five definitions of quality: exceptionality, perfection and consistency, fitness for purpose, value for money, and transformative. These various definitions are described in detail in Harvey and Green's work, but are described here in the concept map in Figure 3.1.

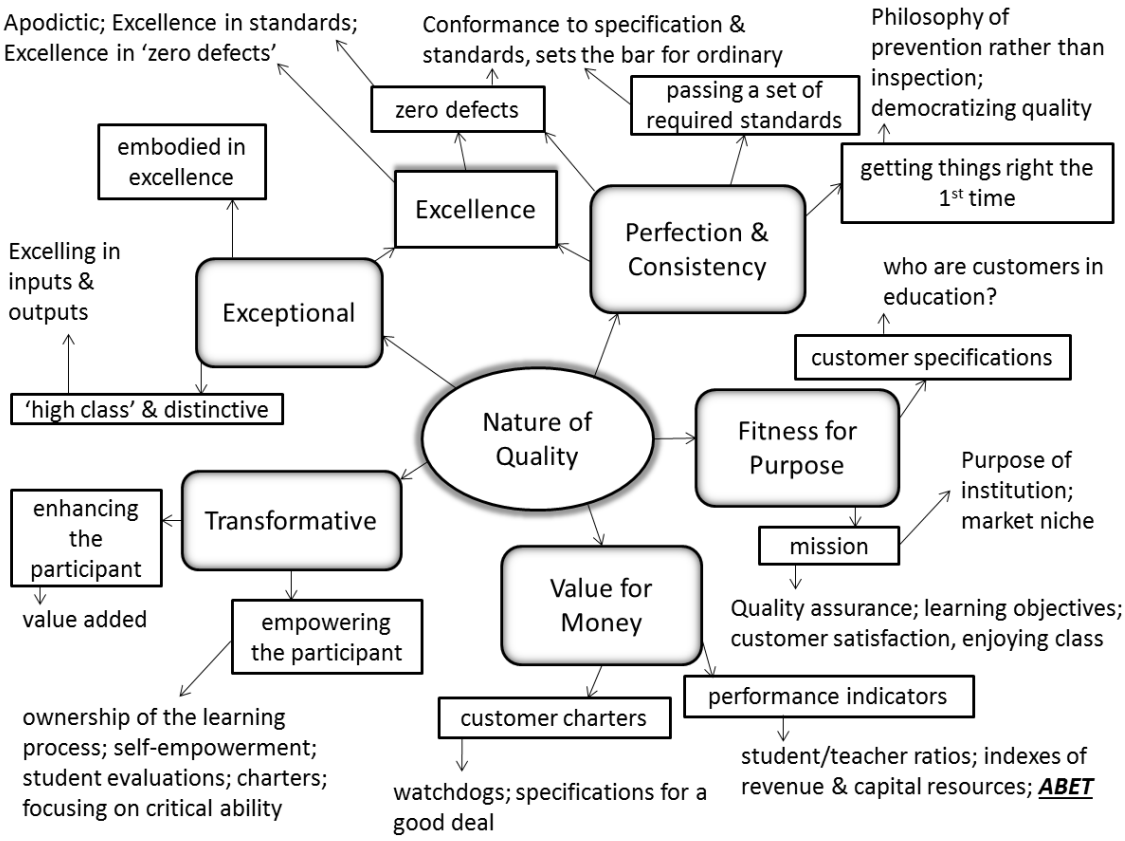

Figure 1: Author's concept map of Harvey and Green's (1993) Defining Quality in the context of engineering education.

Accreditation processes might seem to fit with multiple definitions of quality—the "passing a set of required standards" aspect of the "perfection and consistency", the sensitivity to institutional mission in "fitness for purpose" seems to describe the flexibility that ABET provides in how outcomes are achieved and the type of evidence provided. According to Harvey and Green, a focus on accreditation resonates with the "Value for Money" type of quality, because accreditation is viewed as an outside entity that sets standards of quality. In this sense, accreditation is a process of satisfying an external client. This identification is appropriate—even though ABET is an organization

made up of community representatives charged with helping the profession manage itself, accreditation visitors are always external to the program.

Thus, while ABET does "promote quality and innovation in education, consults and assists in the development and advancement of education worldwide, anticipates and prepares for the changing educational environment and the future needs of its constituents," the mechanism is through the accreditation of the programs. Harvey and Green observe that having performance standards like ABET's works against the "exceptional" definition of quality, because the focus of the exceptional definition is elitism, distinction, and high-class. This definition of quality is consistent with allowing only exceptional students to be admitted into higher education, resulting in higher quality outputs. A focus on the assessment of outcomes, like a criterion-referenced grading system, allows all programs to succeed rather than distinguishing certain programs—there is only one grade of accreditation. If a program meets the standards of accreditation, it is accredited just like all 3,300 other programs (ABET, 2014d; Harvey & Green, 1993). The mismatch in the case of "perfection and consistency" is that this definition of quality focuses on the zero defects type of quality such as is found in the ISO9000 quality standards for manufacturing (Hoyle, 2001). The remaining gray area is "fitness for purpose", which seems appropriate in that the ABET criteria require that a program's educational objectives align with the institution's mission (Criterion 2) (ABET, 2014d; Harvey & Green, 1993).

While there are various criteria for accrediting engineering programs, the most familiar is Criterion 3, Student Outcomes (ABET, 2014c):

"The program must have documented student outcomes that prepare graduates to attain the program educational objectives. Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

(a) An ability to apply knowledge of mathematics, science, and engineering
(b) An ability to design and conduct experiments, as well as to analyze and interpret data
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) An ability to function on multidisciplinary teams
(e) An ability to identify, formulate, and solve engineering problems
(f) An understanding of professional and ethical responsibility
(g) An ability to communicate effectively
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) A recognition of the need for, and an ability to engage in life-long learning
(j) A knowledge of contemporary issues
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice."

Criterion 3 is student focused, aims to develop students into engineers, which fits into the transformative nature of quality. It seems that ABET's Criterion 3 was designed to be transformative, although it could be considered fitness for purpose because of the intended outcomes for the engineering profession. The approach to collecting faculty perceptions about the effects of accreditation was open-ended. Nevertheless, many respondents specifically mention Criterion 3, others make clear reference to it by mentioning "a through k". Others likely described the impact of Criterion 3, but referred to it more generally as "the new ABET standards" or "EC2000" (although that term is little used today).

Seely reported that there have been calls for reform since the 1980s, examples include NRC 1986, NSB 1986, ASEE 1986, 1987, ABET 1986; which led to the Belmont Conference (Daniels, et al, 2011; Seely, 2005). The Belmont Conference led the way for multi-institution, multimillion dollar engineering education programs (Daniels, et al, 2011).

Then in 1993, the NSF program Collaboratives for Excellence in Teachers Preparation (CETP) provided funds to improve how students are taught in undergraduate education, and initially was intended for elementary and secondary teachers, but was renamed STEM (Science, Technology, Engineering, & Mathematics) education (NSF, 1996). This was an effort to make systematic changes in the culture of undergraduate education to aid in the improvements of science, math, and engineering undergraduate education (Walczyk, Ramsey, and Zha, 2007).

By 1996, the Advisory Committee reported to the National Science Foundation (NSF), Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology, made an overriding recommendation that "all students have access to supportive, excellent undergraduate education in science, mathematics, engineering, and technology, and all students learn these subjects by direct experience with the methods and processes of inquiry" (p. ii). The report also makes recommendations to faculty insisting that faculty "believe and affirm that every student can learn, and model good practices that increase learning…" (p. iv).

The National Science Foundation gave a significant portion of its engineering education funding to engineering education coalitions from 1990-2004 (Borrego, 2007). Borrego focused on four coalitions: the Foundation, SUCCEED, ECSEL, and Gateway, which were multi-school multi-million dollar budgets to change engineering education to improve student outcomes, and from that the coalitions moved into assessment, faculty development, and research (2007). These coalitions may have helped influence the reform of ABET (Prados, Peterson, & Lattuca, 2005).

Research on the impact of the revisions to ABET's criteria for accreditation. Many studies cite the major revision of the ABET criteria as a motivating factor for change (Cabrera, Colbeck, & Terenzini, 2001; Cox & Cordray, 2008; Prados et al, 2005; Seymour, 2002; Volkwein, Lattuca, Terenzini, Strauss, & Sukhbaatar, 2004). The previous ABET criteria are typically described as inflexible, rigorous criteria that many engineering administrators describe as a barrier to the reform of engineering education

(Prados et al, 2005). While the revision of the criteria included significant input from the engineering education community through a series of workshops (Prados et al, 2005), the new criteria enjoyed universal deployment, because of its top-down approach to change. ABET has the ability to deny accreditation to an engineering program, causing its institution and other stakeholders to question the validity of the program (Seymour, 2002).

While changes to accreditation requirements provided top-down pressure for change (Prados, Peterson, & Lattuca, 2005), the National Science Foundation's investment in multiple coalitions that received multimillion-dollar-per-year grants helped guide that change to broadly reconsider the way U.S. engineering students are educated (Borrego, 2007). Volkwein, Lattuca, Terenzini, Strauss, and Sukhbaatar (2004) proposed a study of the impact of the revised criteria, and Lattuca, Terenzini, Volkwein (2007) report the results. A comparison of student learning outcomes before and after the revision showed improvement (Lattuca, Terenzini, Volkwein (2007). Lattuca et al (2007) explored the impact of ABET's new criteria on student learning outcomes and on organizational and educational policies and practices, which may lead to improved student outcomes. Lattuca and her colleagues found that over 75% of engineering department chairs reported "moderate to significant increases in their program's emphasis on communication, teamwork, use of modern engineering tools, technical writing, lifelong learning, and engineering design." (2007, p. 3). While two-thirds of respondents reported an increased usage of active learning in their regular courses, only 28 percent attribute these changes directly to ABET (Lattuca et al, 2007).

3.3 Methods

The research questions for this study were: How do faculty describe the influence of the ABET accreditation process on quality teaching? How do faculty definitions of quality teaching influence their views of the ABET accreditation process? How are faculty perceptions of the ABET accreditation process related to faculty teaching practices? To answer these questions, the researchers used both qualitative and quantitative tools. The qualitative study is phenomenological, because we are interested in the experience of faculty who are involved in or affected by the ABET accreditation process. Phenomenological studies describe "the common meaning for several individuals of their lived experiences of a concept" (Creswell, 2013, p. 76), their experience with ABET accreditation and its effect on quality teaching.

Qualitative analysis of open-ended responses. As part of larger study of faculty definitions of quality teaching and influences on faculty teaching practices, faculty were asked "How has the ABET accreditation process affected how you teach, if at all?" as an open-ended survey question. Among the 91 survey respondents from four participating institutions (approximately a 10% response rate), there were 43 responses to this open-ended question. Because these responses were surprisingly rich, this question was analyzed using open and axial coding. Among the respondents to the open-ended question, 60 percent identified as male, 23 percent identified as female, and the remaining 17 percent did not identify as either. As is typical of survey response rates, women are overrepresented.

Responses were not equally distributed by institution, with 21, 23, 49, and 9 percent responding from the four institutions, but there was surprising variability in the primary departmental affiliation of the respondents, as shown in Table 3.9. A primary departmental affiliation was identified by 91 percent of respondents.

Table 3.9**:** Primary department affiliation of respondents.

Primary Department	%
Aerospace	9%
Chemical	5%
Civil	7%
Construction Engineering	2%
Electrical or Electrical and Computer	9%
Environmental	5%
General (Freshman, Fundamentals) Engineering	12%
Industrial and/or Systems	5%
Materials	7%
Mechanical	19%
Mining and Minerals	2%
Nuclear and/or Radiological	2%
Other	7%

Table 3.10 shows the primary position of the faculty participating in this survey. All respondents to the open-ended question reported their primary position. Compared to the overall survey respondents, the respondents to the open-ended question were more likely to be teaching/research faculty.

Table 3.10: Primary position of respondents.

Primary Position	%
Teaching Faculty	16%
Teaching/Research Faculty	60%
Research Faculty	16%
Department Chair	0%
Dean's Office or other administration	5%
Other	2%

Table 3.11 is the reported rank of respondents to the open-ended ABET question. All respondents had reported a rank. There is variability in the respondent rank. The average length of faculty service was 18 years, with an average of 15 years at their current institution. More complete details of the survey administration are available elsewhere (McNeil & Ohland, 2014).

Table 3.11: Faculty rank of respondents.

Current Rank	%
Assistant Professor	7%
Associate Professor	26%
Professor	47%
Instructor/Lecturer	14%
Faculty of Practice	0%
Adjunct/Visiting (any rank)	2%
Emeritus/Retired (any rank)	0%
Other	5%

Quantitative analysis of Likert-type survey responses

Ordinal logistic regression was used to analyze several Likert-type questions measuring faculty responses to ABET accreditation related to teaching.

Ordinal logistic regression is used for categorical dependent variables (Intro to SAS, 2014). Participants received the instructions: “In this question, we ask to what extent the student outcomes focus of ABET accreditation has influenced your approach to undergraduate teaching. Please indicate your agreement with the following statements (1 to 5 with 1 being ‘do not agree’ and 5 being ‘agree completely’):

- Documenting student outcomes takes time away that I would spend preparing to teach.
- Multiple-choice tests provide a more direct measure of student learning.
- Since becoming involved in accreditation, I’ve started using terms like “student outcomes” and “learning objectives.”
- I design learning experiences that address multiple student outcomes simultaneously.

The survey also included multiple questions about specific teaching techniques. These were taken from an earlier survey of teaching practices in the SUCCEED Coalition (Brawner, Felder, Allen, & Brent, 2002):

“Please think of a typical undergraduate course that you teach, and indicate how frequently you use each of the following teaching techniques as indicated by the response choices.” (1 to 5 with 1 being ‘Every class,’ 2 was ‘one or more times per week’, 3 referred to ‘one or more times per month’, 4 was ‘one or more times per semester’, and 5 was ‘never’.

- Lecture for most of the class period?
- Use demonstrations (live or multimedia)?
- Address questions to the class as a whole?
- Put students into pairs or small groups for BRIEF INTERVALS during class to answer questions or solve problems?
- Put students into pairs or small groups for MOST of the class period to answer questions or solve problems?
- Assign homework to individuals (as opposed to teams)?
- Give students the option of working in teams (2 or more) to complete homework?
- REQUIRE students to work in teams (2 or more) to complete homework?
- Give writing assignments (any exercise that requires verbal explanations and not just calculations)?

These questions received between 70 and 86 responses out of the 91 survey respondents.

Considering the quality of the qualitative data (Walther, et.al., 2013), the theoretical validation of this data, while limited by including participants only from large, public, research institutions, other modes of variation are present. The perspective of those of different ranks and positions is included, consistent with an average engineering department. The average amount of time teaching was 16 years, which would indicate that we are not measuring novelty effects. Procedural validation was shown through the use of qualitative and quantitative data to triangulate the results.

Further, the constant comparative method was used to make sure that the researchers were staying consistent with coding the definitions of quality teaching (Walther, et. al., 2013). Communicative validation was not present because this data used an open-ended survey, thus there was only one way communication, but this enhanced process reliability through the use of a consistent survey message given to all the universities with the exact same survey (Walther, et. al, 2013).

3.4 Finding and Discussion

There were 91 surveys collected and 43 faculty responded to the ABET open-ended question, which is 47 percent. The faculty that did comment had done so with length and honesty, which is a condition of quality qualitative research (Walther, Sochacka, & Kellam, 2013). Among the open-ended responses, faculty views were overwhelmingly negative. Comments were identified as negative when they used words or phrases such as: waste of resources/time, not much, hasn't, not at all, awkward, confined my creative process, serve Big Brother ABET, all powerful academic dictator, adds administrative burden, contributes very little, false sense of quality control, false security, not valuable, burdensome, does not contribute to student learning, red tape, administrative nonsense, cripples creativity, huge labor costs, dehumanizes, destroys quality, creates toxic environment, many other negative effects, and drains time and energy. Positive comments were typified by phrases and words such as: helped, make possible, giving students more variety, overall goal is positive, good, and good sense. A brief assessment of the tone reveals 29 negative comments (67 percent), 11 positive comments (26 percent), and three neutral comments (seven percent) that consisted primarily of factual

comments such as: collect student work, aware of ABET accreditation, didn't change my approach, more sensitive. There were a few comments that had positive, neutral, and negative comments in them, and the researcher counted the amount of negative verses positive verses neutral phrases, whichever had a higher count of positive, neutral or negative phrases within the comment was coded as such. All comments in this data had a majority of either positive, neutral, or negative comments. It is critical to note here that it is not the criteria themselves that are having an impact, but it is the way they are enacted by the institution, the person coordinating the collection of Self-Study data, and other stakeholders involved in the process.

Faculty felt that accreditation processes stifled creativity. Of the 29 negative comments, 19 respondents specifically discussed ways in which faculty teaching is negatively affected by ABET accreditation processes, and the respondents touched on surprisingly similar themes. One common theme was that ABET stifles faculty creativity in teaching because of the mandatory requirements for ABET accreditation. One faculty complained that the process "Confined my creative process such that I try to satisfy contrived ABET requirements rather than improve content. We serve Big Brother ABET, not the students. On the bright side, being told what to do and how to teach by an unaccountable all powerful academic dictator does make my job easier (at the expense of those we are teaching)" (#34). This faculty member thinks that ABET accreditation compliance takes away from students and from quality teaching—and expresses the most extreme view of ABET's externality. Another faculty states: "ABET has made me far, far more pessimistic of the future of education. ABET cripples creativity… distracts professors

from teaching and from the students, dehumanizes the teaching process, destroys quality in teaching, drives good people from academia, creates a toxic environment for discussing teaching among colleagues, and many other negative effects. … and stifling our creative excellence" (#66). The inflexibility perceived by some faculty extended to the curriculum as well as approaches to teaching: "…Worse, the fear of ABET creates inertia and inflexibility in curriculum that stifles creative approaches to teaching…" (#77). The ABET accreditation criteria provide flexibility in how a program helps students achieve the outcomes and in how the program provides evidence that students have achieved them, but these faculty do not see the flexibility. This observation relates to other research that has found that faculty responded negatively to being told how to teach in their classrooms and that faculty believe that they should have academic freedom in the classrooms (Herman, 2014). To the extent that faculty feel that the accreditation processes hinder their creativity in the classroom because the student outcomes are standardized, this standardization is at the heart of the accreditation process.

Consequently, there is no resolution except to help faculty understand the process and the reason for its design. On the other hand, to the extent that faculty believe that their creativity is hindered by the way student outcomes are assessed, is a matter of local implementation—how each faculty member's institution, college, program, and colleagues have decided that evidence shall be provided that the student outcomes are being met. Clearly, there is a disconnect between the flexibility of the criteria and those implementing the criteria at the program level.

Some faculty who commented positively about the accreditation process noted the same constraints, but seemed to see this constraint as a normal part of a design process: “It certainly constrains our program, however, we are now in the process of rethinking how we meet the requirements while at the same time giving the students more variety.” (#44). Another respondent acknowledged the same standardization of curriculum, but recognized the benefit: “The importance of consistency from faculty member to faculty member is the key piece. I am not the only one who teaches my course, but making sure that the content and outcomes that I pursue are consistent with those of my colleagues is very valuable…It has caused me to standardize my topics/goals with those of my peers. This is good.” (#90).

Other faculty members were more positive still, and did not address the aspect of constraint that so bothered those who responded negatively: “It has helped bring focus to the more qualitative aims of engineering education—and to make it possible for faculty to discuss these” (#22); this contradicts respondents who indicated that accreditation processes made it harder to talk about teaching with their colleagues—this signals either a difference in how accreditation processes are being implemented or a difference in the perspective of these faculty that causes them to respond very differently to the same conditions. The departmental climate regarding accreditation may have more impact than the accreditation process itself. Other faculty report new ways of thinking: “It forces me to think about outcomes, which is a good thing” (#68), “I became more sensitive to ensuring that specific assignments map to ABET learning objectives, and I include a

discussion of those learning objectives in the introduction to the course" (#76), and "It helps me create a list of subject specific learning objectives at the semester level." (#88).

Faculty say that the workload of accreditation keeps them from more important activities. Faculty who feel burdened by the accreditation process see it as unproductive time: "ABET harms my teaching by soaking up countless hours in unproductive work. ABET restricts creativity in teaching. ABET destroys our innate love of teaching…" (#86). Some faculty who acknowledge the benefit of accreditation and assessment in general, but resent the current implementation: "The overall goal of ABET is positive, but the current structure of the process is burdensome, and does not contribute to student learning." (#56). Another faculty comments, "What a waste of time. Real evaluation great. This is an exercise in red tape and administrative nonsense." (#63). This faculty member thinks that the way ABET does evaluations is not actually evaluating anything and is wasteful. These faculty members do not see ABET as a quality standard that helps students' learning, which is disconcerting because quality education is in both ABET's vision and mission statements.

Some faculty express the burden of accreditation in terms of its financial cost. While some faculty expressed this cost concern briefly "…ABET drives up the cost of education." (#86), others expounded the cost in time and money: "ABET is a tremendous waste of resources. It detracts greatly from time which could be spent improving teaching. Show me represented graded exams from the courses and I will tell you whether the

students are learning the appropriate material and how well they are learning it. Everything else is just a waste of time and money." (#4).

Some faculty felt so strongly about this issue that they suggested that engineering programs take collective action to change the process. One faculty writes, "I find ABET a complete waste of time and I think it is time for engineering departments to stand up and say this is not what we are going to do." (#45). Another makes more specific recommendations "…induces huge labor costs at universities …Quality can be improved immediately by: 1. Providing time, money, and support staff (true support staff, not administrators) to professors to implement their good ideas, 2. Join with other [peer] engineering schools to declare publicly that the ridiculous and hyper-expensive ABET process is driving up the cost of education…" (#66). One faculty member felt that the accreditation process was particularly unnecessary in the case of elite institutions: "…adds administrative burden and contributes very little to improving student outcomes. I was teaching long before ABET and it adds nothing but more work and a false sense of quality control. If [a particular elite institution] eschewed ABET accreditation would anyone doubt the quality of the education they provided? It provides nothing more than a false security and 'image over substance'." (#36).

Some faculty believe that restricting access is the way to ensure quality. Among Harvey and Green's (1993) definitions of quality in higher education, we noted that accreditation process are associated with the 'Value for Money' definition because it is associated with meeting the needs of an external stakeholder. Where faculty hold a different view of

quality, it affects their views of the accreditation process. Faculty who hold the "quality is exceptionality" definition describe accreditation as a normative process that inhibits quality: "…ABET is out of touch with reality [that] the world's top schools teach more successfully than the lesser schools. ABET works to drag down the top schools to the level of the lesser schools…" (#66). This faculty member proposes that the way to improve quality in education is to improve the students admitted to the school: "Admit only the qualified students; it's shocking how many engineering undergrads cannot write a sentence and don't know high school algebra and geometry." (#66). This creates a lot of tension when faculty, administrators, industry leaders, students, and stakeholders try to collaborate on maintaining or improving quality in higher education. This resonates with some of the criticisms of No Child Left Behind—that excessive standardization stifles exceptionality (Ryan, 2004).

If faculty view ABET accreditation as a barrier to quality education, nobody benefits—if faculty feel stifled or burdened, they will challenge the efforts of administrators, and withdraw from interaction with students. To the extent that accreditation intends to assure and improve the quality of engineering education, when faculty have different perspectives of quality, it is naturally challenging to reach consensus on the best approach to accreditation. It is therefore important to consider varying faculty perspectives of quality when designing local practices in preparing for accreditation. It is valuable to consider how faculty with each definition of quality can contribute to the accreditation process.

ABET influence on approach to teaching. The relationship of ABET influence on faculty's approach to teaching was studied using logistic regression. Neither gender nor faculty rank was found to play a role in a faculty member's attitude about ABET's influence on teaching quality, so those were removed from the model and are not discussed further.

Table 3.12: Means of each of the ABET influences by gender.

Gender	Doesn't document	Multiple-choice tests	Uses "student outcomes" & "learning objectives"	Creates multiple levels of learning
Male	2.97	1.37	3.07	3.32
Female	2.90	1.50	2.94	3.76

Table 3.13: Means of each of the ABET influences by university.

University	Doesn't document	Multiple-choice tests	Uses "student outcomes" & "learning objectives"	Creates multiple levels of learning
A	3.13	1.63	2.75	3.26
B	2.71	1.43	3.17	3.54
C	3.23	1.14	2.71	3.10
D	2.83	1.20	3.50	4.00

Table 3.14: Means of each of the ABET influences by rank.

Rank	Doesn't document	Multiple-choice tests	Uses "student outcomes" & "learning objectives"	Creates multiple levels of learning
Assistant	3.42	1.54	3.27	3.62
Associate	2.61	1.18	2.85	3.65
Professor	3.12	1.40	2.79	3.27
Instructor	3.46	1.67	3.27	3.31

Faculty perceptions of the accreditation process are related to their teaching practices. As a measure of how the process of ABET accreditation influences faculty approaches to undergraduate teaching, faculty were asked to express their level of agreement with various statement related to the faculty member's interpretation of ABET's principles and practices.

Responses to "documenting student outcomes takes time away that I would spend preparing to teach" are unrelated to gender, total years as a professor, and institution. Faculty who disagreed with that statement were more likely to "require students to work in teams (2 or more) to complete homework". Specifically, faculty who disagreed with the statement had a 38% probability of requiring students to work in teams (2 or more) to complete homework each week [$b = -0.50$, χ^2 (1, $N = 84$) = 7.62, $p < 0.05$ (odds ratio = 0.607)].

Faculty also indicated their agreement/disagreement with the statement: 'Multiple-choice tests provide a more direct measure of student learning.' Again, responses to this statement were unrelated to the faculty's gender, total years as a professor, or their university. 'Do not agree' was the referent group in this analysis. Faculty who disagreed that "multiple-choice tests provide a more direct measure of student learning" were unlikely (18 percent probability) to "Address questions to the class as a whole" [$b = -1.53$, χ^2 (1, $N = 80$) = 7.05, $p < 0.05$ (odds ratio = 0.217)].

Since one step in adopting a new paradigm is learning and using new terminology, we asked a question about the adoption of terminology related to ABET accreditation and a pedagogically related term: "Since becoming involved in accreditation, I've started using terms like 'student outcomes' and 'learning objectives'. Responses to this statement had no relationship to gender or total years as a professor, but agreement with this statement was related to the respondent's university [$b = 0.28$, χ^2 (1, $N = 72$) = 4.28, $p < 0.05$ (odds ratio = 1.32). 'Do not agree' was the referent group in this analysis. We have previously noted that the observed reactions to the ABET's accreditation is really a reaction to the way that those processes are applied at the program level. This finding is a reminder that there are typically institutional norms regarding how engineering programs manage reaccreditation. At the large public universities sampled in this study, there is college-level coordination of the response to accreditation processes, so it is not surprising that the degree to which faculty are educated about and adopt ABET-related terminology would differ by institution. Increased agreement with this statement regarding accreditation terminology predicted decreased likelihood of "Put students into pairs or small groups for BRIEF INTERVALS during class to answer questions or solve problems". [$b = -0.39$, χ^2 (1, $N = 77$) = 4.05, $p < 0.05$ (odds ratio = 0.68].

The data show no relationship between "'I design learning experiences that address multiple student outcomes simultaneously" and their gender, total years as a professor, and their university. 'Do not agree' was the referent group in this analysis. An increase in agreement with that statement resulted in increase that a faculty member would "require

students to work in teams (2 or more) to complete homework" [$b = 0.36$, χ^2 (1, $N = 82$) = 4.12, $p < 0.05$ (odds ratio = 1.44].

3.5 Conclusions

The research questions for this study were: How do faculty describe the influence of the ABET accreditation process on quality teaching? How do faculty definitions of quality teaching -influence their views of the ABET accreditation process? How are faculty perceptions of the ABET accreditation process related to faculty teaching practices?
In our qualitative findings, faculty largely described the ABET accreditation process as having a negative influence on quality teaching—some faculty expressed concern that the accreditation process distracts faculty from having a positive influence, whereas others expressed more dire views that the accreditation process imposes a uniformity that benefits neither the students nor the faculty. A minority of faculty expressed more positive views, describing how the accreditation process has helped them think more about teaching or in improving their teaching through improved coordination with other faculty. Some qualitative responses revealed a connection between a faculty member's definition of quality teaching and their view of the accreditation process, but this was not a dominant theme.

Through quantitative analysis, we showed that faculty who express various negative views of either the goals or the practice of accreditation are less likely to engage in certain teaching techniques that are more student-centered and more likely to engage in passive delivery.

More positively, our findings show that faculty who tend to agree with the student outcomes focus of the ABET criteria engage in richer educational experiences—they give students requirements to work in teams and allow students to learn collaboratively. Unfortunately, the majority of faculty still disagree with the philosophy of the accreditation process or how it is practiced.

Whereas the shift of the ABET accreditation process to a student outcomes focus should give programs and faculty flexibility in how to achieve and measure those outcomes, that flexibility is not being realized by a large majority of the faculty in this study. This issue cannot be addressed simply by educating faculty about the value of accreditation, because our qualitative findings show that even faculty who understand and value the goals of the accreditation process express significant concerns about the way that it is being implemented at the program level. Thus to help many faculty realize the benefits of the accreditation process, it will be necessary to address how it is being implemented—the policies and practices established by program administrators and others who influence—or constrain—the way in which program faculty achieve and document student outcomes. As a Program Evaluator for ABET, Dr. Matthew Ohland sometimes provides input to programs on how assessment process might be simplified and reduced where they appear to be burdensome. This work will be shared with the staff at ABET headquarters, so one possible outcome of this work will be to help Program Evaluators see how they might recognize, value, and promote a diversity of ways of achieving and assessing student outcomes while minimizing the burden on administrators and program faculty.

CHAPTER 4. FACULTY PERSPECTIVES AND INSTITUTIONAL CLIMATE FOR TEACHING QUALITY IN ENGINEERING

4.1 Introduction

It has been shown through research that innovative pedagogies are a better approach to student learning than lecture based methods. Researchers have tried to 1) measure what faculty are actually doing in their classrooms, and 2) convince faculty to adopt a variety of different pedagogies. Nevertheless, teacher-centered methods still dominate in the engineering classrooms. This research will look at faculty perceptions about quality teaching to understand why they make the choices they make and to help gain further insight into the change process. In this study, the researchers aim to discover the influence of institutional climate on a faculty member's choice of pedagogy. Climate is measured by faculty members' perceptions of the attitudes toward teaching quality of peers, administrators, and college policies and practices.

This study builds on the previous work from the Southeastern University and College Coalition for Engineering Education (SUCCEED) surveys that were collected from 1997, 1999, and 2002 of faculty teaching practices. The researchers collected a new, updated survey with many of the same questions in 2014. The survey was sent out to all engineering faculty at each of the participating institutions in 1997, 1999, and 2002:

Clemson University, Georgia Tech, Florida A&M-Florida State University, North Carolina A&T State University, University of Florida, University of North Carolina at Charlotte, and Virginia Polytechnic Institute and State University. In 2014, the survey was sent out to Purdue University, University of Colorado, University of Florida, and the University of North Carolina at Charlotte. There were 503 surveys collected in 1997, 511 surveys in 1999, 375 surveys in 2002, and 97 responses in 2014. The quantitative findings of the first three surveys have been published in multiple venues, but free-response comments collected in these survey have never been analyzed. The comments in these surveys inform our understanding of faculty perceptions of quality teaching. Using open and axial coding, we have identified several emerging themes and findings that differ among the survey administrations.

We seek a clearer understanding of the faculty's definition of quality teaching and the importance ascribed to teaching quality. It is critical for researchers to understand what faculty have thought about quality teaching to target faculty development efforts and institutional policies. This research used unanalyzed data from free-response questions on surveys administered by Southeastern University and College Coalition for Engineering Education (SUCCEED) in 1997, 1999, 2002, and the distribution of the updated survey in 2014 by the authors.

The Southeastern University and College Coalition for Engineering Education (SUCCEED). In 1992, SUCCEED was formed as an NSF-sponsored coalition of eight colleges of engineering to promote a comprehensive reform of engineering education.

The coalition partners were: Clemson University, Florida A&M University, Florida State University, Georgia Institute of Technology, North Carolina State University, North Carolina A&T State University, University of Florida, University of North Carolina at Charlotte, and Virginia Polytechnic Institute and State University. The eight colleges are affiliated with nine universities because Florida A&M University and Florida State University have a joint College of Engineering. The reforms researched and implemented from 1992-2002 included efforts to improve faculty preparedness to use alternative teaching methods and alter faculty perspectives on pedagogy, (Ohland, Felder, Hoit, Zhang, & Anderson, 2003; Brent, Felder, Regan, Walser, Carlson-Dakes, Evans, Malave, Sanders, & McGourty, 2000; Brent & Felder, 2002; Brent & Felder, 2003) promote curricular change, (Ohland, Anderson, Ollis, Phillips, Murray, & Hebrank, 1999; Al-Holou, Bilgutay, Corleto, Demel, Felder, Frair, & Wells, 1998; Ohland, Rajala, & Anderson, 2001) and facilitate the shift to an outcomes-based culture (Brawner, Anderson, Zorowski, Serow, & Demery, 1999).

4.2 Literature Review

The teaching climate in engineering may be keeping students away. About one-third of students in the United States receive bachelor's degrees in STEM, while in China, Japan, and Singapore over half of students get bachelor's degrees in STEM fields (Thomasian, 2011). NSF funded a research study that focused on 6th through 12th graders in the United States and their opinions of engineering and found misconceptions regarding what engineers do and how engineers affect the students' daily living, (National Academy of Engineering, 2008). A variety of reports and publications raise the concern that a lack of

focus on teaching quality is a hindrance to recruitment and retention of students in science, technology, engineering, and mathematics (STEM) in general and in engineering in particular. In this context, the adoption of student-centered teaching methods has been suggested as a critical tool for meeting the demand for STEM graduates (Henderson & Dancy, 2008; Prince, 2004; Seymour, 2002; Seymour & Hewitt, 1997). Tinto studied attrition of college students and wrote that the climate in mathematics, science, and engineering is cold and distant, which contributes significantly to why students leave (Tinto, 1987; 1993). Seymour and Hewitt report that traditional-style teaching was a common complaint of all Science, Math, and Engineering students that were interviewed and it was the primary reason for switching away from these programs for over a third of those who switched (1997, p. 145-146). There are still many intrinsic and extrinsic barriers preventing faculty from adopting research-based pedagogy (Felder, Brent, & Prince, 2011).

Cooperative learning yields the best learning outcomes. A wide variety of student-centered learning approaches are generally associated with quality teaching because of the learning improvements that they achieve. Active learning has been referred to as an umbrella term that encompasses many of the student-centered teaching methods, including collaborative and cooperative learning (King, 1993; Prince, 2004). Collaborative learning achieves similar outcomes to cooperative learning, but with a smaller effect size, and is a more feasible alternative for many faculty (Prince, 2004). Prince reviewed the literature on cooperative learning and concluded that "cooperation is more effective than competition for promoting a range of positive learning

outcomes…enhanced academic achievement and a number of attitudinal outcomes" (2004, p. 227). Studying cooperative learning in chemical engineering, Felder, Felder, and Dietz showed that a sequence taught with cooperative learning had multiple benefits over a traditional approach, including higher retention, higher critical thinking skills, better peer interactions, and improved performance and attitudes (1998).

Simpler forms of active learning are still an improvement over lecturing. Bonwell and Eison reported that active learning leads to better student attitudes, writing, and thinking skills. Prince summarized a variety of evidence for active learning and concluded that the results show that active learning results in better student learning (1991; 2004). Alison King asserts that the construction of knowledge must be done by each individual, thus teachers must help students re-construct information to know, and have knowledge (1993). King introduced the "think-pair-share" approach as a low-barrier method to incorporate active learning in the classroom in the hope that active learning methods would become ubiquitous. Likely the best-known study of the outcomes of active learning was a meta-analysis of the use of active methods in physics education. Hake shows that active methods (called "interactive engagement" in Hake's work) increased conceptual understanding compared to non-interactive (lecture-focused) methods in introductory physics courses (Hake, 1998). A pre- and post-physics concept inventory was given to 6,542 students from high schools, colleges, and universities to find that students in interactive engagement courses had an average of two standard deviations higher increases from the post-test than students in the non-interactive engagement introductory physics course. While McKeachie shows that a discussion format provides

only a small improvement compared to lecture, there was still improvement (McKeachie, 1972).

There have been large-scale efforts to change engineering teaching practices. The Vanderbilt-Northwestern-Texas-Harvard/MIT (VaNTH) Engineering Research Center yielded further initiatives in faculty development. Cox has studied faculty teaching practices using the "How People Learn" (HPL) framework. Cox and colleagues asked faculty how effective their teaching was after having participated in VaNTH, and what their perspective was before the program (Cox, Cawthorne, McNeill, Cekic, Frye, & Stacer, 2011). They demonstrated an increase in the use of effective teaching methods after participating in the program. Recognizing the prevalence of lecture-based instructional methods, Cox's finding that "respondents were most likely to describe themselves as student-centered instructors who believed in engaged learning" suggests that by studying VaNTH participants, a significant selection bias resulted. Only "some" of Cox's respondents had a "lecture-based" view of effective teaching. Further, some of Cox's work includes an exploration of differences by faculty rank, an approach used in earlier studies of survey data from SUCCEED faculty (Cox & Harris, 2010). An advantage of the data collected from faculty at SUCCEED institutions is that the survey was sent to all institutional faculty. Thus, while the SUCCEED data may still have a participation bias, the data were not collected exclusively from faculty who were engaged in NSF-sponsored engineering education reform.

There are still significant barriers to the adoption of student-centered teaching methods. Engineering faculty are aware of student-centered pedagogies. It has been reported that roughly 82% of engineering faculty know about research-based pedagogies but only 47% are using them (Borrego, Froyd, & Hall, 2010). A more recent study looking at faculty from across all disciplines showed that science, technology, engineering, and mathematics (STEM) faculty are the least likely to use student-centered teaching methods (Eagan, Stolzenberg, Berdan Lozano, Aragon, Suchard, & Hurtado, 2014). Felder notes that faculty rarely receives formal instruction in teaching (Felder, Felder, Mauney, Hamrin, & Dietz, 1995). In spite of the wealth of research that shows that student-centered pedagogies are a better form of teaching, many faculty still believe that good knowledge of the subject being taught is all that is needed for effective college teaching (McKeachie, 2007). Other barriers to why faculty do not use student-centered pedagogies have been identified as increased preparation time, a concern for covering all the material in the syllabus, student resistance, fear of not getting promoted, and limited resources and facilities (Borrego, Froyd, & Hall, 2010; Dancy & Henderson, 2010; Henderson & Dancy, 2007; Finelli, Richardson, & Daly, 2013). Jaskyte, Taylor, and Smariga looked at faculty and student perceptions in a research study where faculty and students free-listed innovative teaching characteristics and found that student and faculty have different perceptions of innovative teaching (2009). They also noted differences between faculty and between disciplines on the definition of innovative teaching, which can create barriers to innovation and to faculty development. If faculty believe they understand and can engage in innovative teaching, they may not seek to develop new skills or discover their misconceptions.

A study by Serow and colleagues claimed that faculty who were interested in new approaches to teaching, were funded for teaching-reform projects, served as an undergraduate coordinator or on a curriculum committee, and/or had received an outstanding teaching award were more interested in quality teaching than faculty that did not participate or get awards for their teaching (2002). They discovered two unique different groups of faculty within this subgroup: one that embraced faculty development initiatives, the Scholarship of Teaching movement, and the work of campus wide teaching centers in general (Serow, Van Dyk, McComb, & Harrold, 2002). The other group in particular opposed educational research and related funding, believing that these interfered with teaching as the primary role of a professor. Serow was the lead evaluator of the SUCCEED Coalition in its early years, and the study reported in this work was conducted at SUCCEED partner institutions.

Climate in higher education has been studied from a variety of perspectives (Seymour, 2002; Tinto, 1997). The research on climate most relevant to this work was done in the context of physics higher education. Henderson and Dancy (2007) theorized that a departmental climate could have a significant effect on faculty's choice in teaching techniques. Henderson and Dancy conducted five interviews with physics professors and came up with the model in *Figure 4.2* (2007). They claim that a faculty member that wants to teach non-traditionally (alternative) in a departmental climate that is very traditional, will have mixed, both non-traditional and traditional, teaching techniques, even though they believe in using non-traditional teaching techniques (Henderson & Dancy, 2007).

Likewise, if a faculty member is used to traditional teaching techniques and joins a department that supports and encourages non-traditional teaching techniques, then they would be more likely to start using some non-traditional techniques. The research acknowledges that there needs to be more exploration of this model because it had a small sample of physics faculty (Henderson & Dancy, 2007). Henderson and Dancy continued exploring the root causes of the lack of adoption of nontraditional teaching methods in science education, creating an adoption-invention continuum (2008).

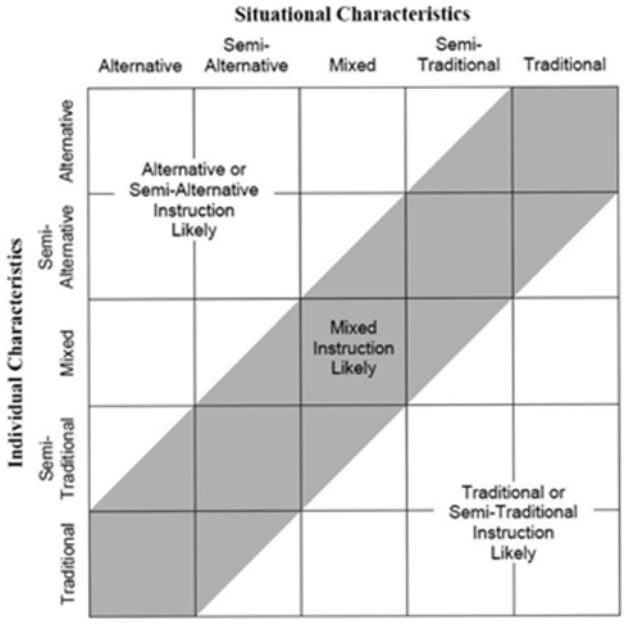

Figure 4.2: Model proposed by Henderson and Dancy showing the interaction of individual and situational characteristics of the teaching methods of physics faculty (2007).

This work will use this model as a framework to explore the effect of climate on faculty members' pedagogical choices.

4.3 Methods and Data

This study is an effort to assess changes in faculty perceptions of quality teaching practices. In 1997, members of SUCCEED's faculty development and assessment teams designed a faculty survey of instructional practices and attitudes regarding the climate for teaching on the Coalition campuses. The survey respondents were asked about the frequency with which they used various teaching methods (such as active learning, team homework, and technology-assisted instruction), their involvement in faculty development programs, and the effect of faculty development workshops on their teaching. They were further asked to rate the importance of quality teaching to themselves, their colleagues, and their department, college, and university administrators and about the faculty reward system at their university. The survey was first administered in late 1997 (Felder, Brent, Miller, Brawner, & Allen, 1998; Brawner, Felder, Brent, Allen, & Miller, &, 1999), modified and administered a second time in 1999 (Brawner, Felder, Allen, & Brent, 2001; Brawner, Felder, Allen, & Brent, 2002), and modified slightly in 2002 for a third administration (Brawner, Felder, Brent, & Allen, 2004). These three survey administrations yielded 503 usable responses in 1997, 511 responses in 1999, and 375 responses in 2002. A comprehensive analysis of trends across all three administrations was published after the third administration (Brawner, Felder, Allen, & Brent, 2002). The survey was modified to update technological terms and to add questions that are studied elsewhere, and was administered in 2014. Because we wanted faculty to report on their recent experience, all participants had taught undergraduate students in the past three years.

It was expected that the 2014 data would allow the researchers to explore how the themes from those earlier administrations might be different a decade later and at institutions that did not participate in one of the NSF-sponsored Coalitions. Additional institutions were invited to participate in the survey, even though those new institutions would not have comparison data from earlier administrations. While the process of recruiting survey participants in 2014 was quite similar to the earlier administrations, much had changed in the culture of engineering education. While relationships and partnerships developed from the SUCCEED Coalition continue (e.g., Ohland & Long, XXXX), the NSF support for the Coalition ceased in 2002. As a result, even where the ties of political capital are strong enough to have the survey deployed by a high-level college administrator, the SUCCED name recognition and the reciprocal benefit of Coalition funding that bolstered response rates in the past had weakened. Further, the ubiquity of electronic survey tools has made it easier to survey—and over-survey—university faculty. To manage this issue, universities are developing policies and procedures governing the distribution of surveys (e.g., OIRP, 2014). More complete details of the survey methods are provided elsewhere (McNeil & Ohland, 2014). A combination of low institutional participation and low participant response rate made it impossible to compare the 2014 responses to the earlier responses as intended, and two related studies evolved that combine to develop a clearer picture of faculty teaching practices than either study alone.

Changes in the influences on quality teaching during the SUCCEED Coalition. The current study focuses on data from the last survey question—an open-ended question,

"Please provide any comments you may have about the quality or importance of teaching on your campus." In the earlier administrations, it was noted that, perhaps because of the placement of this question at the end of the survey, faculty commented not only on the quality or importance of teaching, but also on the survey and other matters. These comments from the 1997, 1999, and 2002 surveys had not been studied previously, so they were used to identify influences on quality teaching and patterns of change from the 1997 administration to 2002 administration.

The perspective that each faculty member brings to the teaching process might suggest a phenomenographical approach that would study the limited number of qualitatively different ways that faculty experience the influence of climate on their pedagogical choices. A phenomenographical approach would have been hindered by the lack of longitudinal connectedness of the data from the multiple administrations—even if faculty had responded in multiple administrations, it was not possible to study the perspective of individual faculty from one administration over time, so it was not possible to study the limited number of qualitatively different ways in which faculty decided to change their pedagogical practices.

Earlier quantitative studies showed changes in teaching practices in subsequent administrations and a relationship between faculty values and the values of others at an institution. Studying data from the first three administrations, we address the research question: How did faculty describe the quality and importance of teaching on their campus, and how did those descriptions change over time? To answer this research

question, the open-ended comments from 1997, 1999, and 2002 were studied using thematic analysis. Responses from the earlier surveys were studied using a constant comparative methodology. Using open coding, the researcher compared and contrasted events, actions, and/or interactions among the faculty comments. The researcher grouped conceptually similar events into categories. Open coding was followed by axial coding, in which categories were related to subcategories and the analysis tested these relationships against the data. Selective coding was the next level of analysis where all categories were unified around core ideas and descriptive detail is added to the categories needing further explication. The combination of open coding across all three administrations followed by axial coding made it possible to study the prevalence of various codes across the administrations to study longitudinal change. While this study does not have sufficient control to claim that all observed changes are due to Coalition activities, the Coalition undoubtedly had some influence.

The influence of climate on quality teaching (data from the 2014 administration).

While the differences in sampling procedure for the 2014 administration made it unlikely that responses from 2014 could be compared to those from earlier administrations, similar methods were used to analyze qualitative comments from the 2014 administration. In addition to studying the open-ended comments from the 2014 survey, this study also used quantitative responses describing the use of certain teaching methods and stakeholder views on quality teaching. The data needed to replicate this study was collected in 1997, 1999, and 2002 as well, but was not available when this work was conducted. Using axial coding to analyze those earlier administrations with the same

codes will be a valuable addition to this work. As noted, however, because of differences in the sampling protocol, the 2014 results cannot be compared to the earlier results. Two-thirds of the data collected in 2014 was from institutions that were not part of the original SUCCEED coalition.

The 2014 administration included quantitative responses regarding the importance of quality teaching to various stakeholders. Specifically, the question stem was, “How important is quality teaching to” followed by these stakeholders: “you”, “faculty colleagues”, “the department head”, “the dean”, and “top administrators”. Responses were collected on a 7-point Likert-type scale from 1 (Not important at all) to 7 (Extremely important). These responses were not studied quantitatively, but were used to classify the environment for quality teaching as either “supportive” (faculty who answered a six or seven for at least two of the climate questions) or “non-supportive” (faculty who reported a one or a two in at least two climate questions).

Similarly, faculty teaching methods were classified as “traditional” or “nontraditional”. The questions used for this part of the research used the stem, “Please think of a typical undergraduate course that you teach, and indicate how frequently you use each of the following teaching techniques as indicated by the response choices.

Q1. Lecture for most of the class period

Q2. Put students into pairs or small groups for MOST of the class period to answer questions or solve problems

Q3. Assign homework to individuals (as opposed to teams)

Q4. REQUIRE students to work in teams (2 or more) to complete homework

Q5. Give writing assignments (any exercise that requires verbal explanations and not just calculations)

The response choices for these questions were “every class”, “one or more times per week”, “one or more times per month”, “one or more times per semester”, and “never”. Lecture (Q1) and assigning homework to individuals (Q3) were reverse-coded. Similar to the previous study, constant comparative analysis was used to explore faculty members’ comments from the last question on the survey, “Please share any comments about the quality or importance of teaching on your campus.” Because the respondents are being classified into subgroups for analysis, the method used here is more characteristic of a collective case study (Stake, 1998), where the richness of the case comes from qualitative and quantitative data from the participants in each group rather than exclusively from richer qualitative data from each participant.

Considering the quality of the qualitative data (Walther, et.al., 2013), the theoretical validation of this data, while limited by including participants only from large, public, research institutions, other modes of variation are present. The perspective of those of different ranks and positions is included, consistent with an average engineering department. The average amount of time teaching was 16 years, which would indicate that we are not measuring novelty effects. Also, there was a negative case analysis done with faculty putting faculty into non-supportive and non-traditional teaching quadrants. Procedural validation was shown through the use of qualitative and quantitative data to

triangulate the results. Further, the constant comparative method was used to make sure that the researchers were staying consistent with coding the definitions of quality teaching (Walther, et. al., 2013). Communicative validation was not present because this data used an open-ended survey, thus there was only one way communication, but this enhanced process reliability through the use of a consistent survey message given to all the universities with the exact same survey (Walther, et. al, 2013).

4.4 Results and Discussion

The 1997 survey was intended as a baseline survey after some faculty development interventions, but before a concerted effort made by SUCCEED during 1997-2000. In 1997, comments were included by 147 of the 503 respondents. In 1999, 195 of 511 respondents provided comments. In 2002, 113 of 375 respondents did so. The survey respondents in 2014 provided 37 comments in 97 responses. Overall, the comments in 1997 were more negative than later surveys when asked about the quality or importance of teaching quality, with 90 percent making negative comments and 63 percent having positive comments in that administration. In 1999, only 55 percent made negative comments, 47 percent in 2002, and 65 percent in 2014 (recall that the 2014 sample includes different institutions). In spite of the reduction in the prevalence of negative comments from 1997 to 1999 to 2002, positive comments were outnumbered by negative comments each survey year, which is a finding in itself that agrees with the earlier discussion of barriers to pedagogical change (Felder, Brent, & Prince, 2011).

Student evaluations evolve from a negative burden to positive evidence of student learning. Many faculty commented on how the university administration measures quality teaching, which was mostly measured through student evaluations. In 1997, 18 responses mentioned student end-of-course evaluations about their teaching. Faculty resented being evaluated by students who they viewed as unqualified for the task. *"Too much emphasis is placed upon student evaluations of teaching effectiveness in spite of the fact that the students have no metric for what is important for them to learn…" (#76, 1997).* This raises an interesting dialog about students' ability to understand what they need to know to be an engineer, and is still debated in the engineering community. Another faculty member said, *"We measure student opinions on every course and instructor; these opinions strictly measure student comfort and bear no relation to how much students learn" (#317, 1997).* These faculty perspectives run counter to significant evidence that student evaluations of teaching correlate well with a variety of other measures of teaching effectiveness (Felder, 1992). The second comment is of particular concern, because if the faculty member believes that student evaluations measure comfort, then there is a disincentive to push students out of their comfort zone—by using non-traditional teaching methods or even by challenging the students. Considering Vygotsky's notions of a zone of proximal development (1978), this approach is not likely to create a positive environment for learning (Vygotsky, 1978). To support this faculty member, institutional support would be critical—so that the faculty member knew that they would be able to weather student resistance to innovative teaching methods.

In 1999, 16 faculty mentioned student end-of-course evaluations in response to the same question. Thus, there were more overall comments but fewer comments about student end-of-course evaluations in 1999. One faculty member seems to try to articulate the dilemma identified from the 1997 data—*"Meaningful quality assessments are not systematically made. The student critiques that are used to judge faculty may be having a detrimental effect on the quality of teaching" (#392, 1999).* Fear of poor evaluations leads faculty to engage in teaching practices that will not attract negative attention. Only four faculty respondents in 2002 commented about student end-of-course evaluations, and two of those comments were positive comments describing high student evaluation marks. The multiple administrations of the survey occurred over a span of five years, and these findings suggest that faculty shifted their perceptions about student evaluations during that time.

Many faculty claim that administrators care little about teaching, but "pay it lip service". There was a sense that university leadership says teaching is important but doesn't reward it, as expressed in 29, 23, and 10 comments in the three successive surveys. There was surprising consistency in the words used to express this problem, with the phrase "lip service" used often.

"[Teaching] is important personally to many of the faculty but gets only lip service from administration. Lousy teaching is punished by the dean, but superior teaching is usually ignored or resented for the popularity it engenders for the individual instructor" (#23, 1997). Based on this quote, while the Dean acts as an authoritarian in enforcing the

cultural demand for substandard teaching, faculty peers act to suppress teaching that stands out for its quality. Faculty also articulated the overvaluation of research and the undervaluation of teaching: *"At a research university, research is the only item that really matters. If a faculty member is obtaining significant grants, he/she may not even be required to teach! Those who only teach are treated as second-class citizens. They are considered intellectually second-class and their salaries reflect the true value placed on their services by the administration" (#270, 1999).*

One faculty member wrote in 2002: "*The administration doesn't take teaching seriously, even though they claim to do so. Spending time on teaching is suicidal for a career." (#32, 2002).* Faculty perspectives from 1997 through 2002 are rife with disincentives to quality teaching.

Among the cynics, some spoke positively about their campus' commitment to quality teaching. There were some faculty that thought their college, colleagues, and department were doing a better-than-average job of teaching. In 1997, there were 21 comments that expressed positive views of teaching on their campus, about 14 percent of the total comments that year. One faculty member commented "*I am fairly well pleased that this university seems to take teaching pretty seriously. An effective teacher can do well here, even if they are only average at research. That is not the case at many schools." (#149, 1997)*. Many faculty who made positive comments in 1997 echoed the expectation that this was atypical in the university setting. Another comment, "*Based on my time here at XX, I believe the College of Engineering is truly committed to providing a quality*

educational experience for the undergraduate students, and I believe they generally achieve that goal." (#440, 1997).

In 1999, the number of positive comments increased to 45, 23 percent of those who commented, and the most of all 3 surveys. These faculty thought their department or college was doing a good job of recognizing quality teaching and supporting its importance. One faculty states "*Teaching is the primary mission and the faculty respects this. Research is a tool to compliment teaching of new science and ideas." (#24, 1999*). The comments were less likely to express this as being uncommon or unusual. Some faculty expressed the importance of being a good teacher in the promotion process, "*It is the "ticket of admission" to our faculty; if you're not devoted to it and good at it, you don't get appointed, tenure, promoted, raises." (#99, 1999*).

There were 22 positive comments about quality teaching in 2002, about 19 percent of the total comments. "*I believe teaching is considered of high importance in this institution, with its land grant state university character, and I like that. I believe overall teaching quality to be quite high as well." (#183, 2002*).

Diverse perspectives on quality teaching are evident. The perspective that highly-skilled researchers are automatically highly-skilled teachers as well was found, even in the final survey: "*Research faculty provide the state-of-the-art teaching facilities used for undergraduate education. This is clearly why great research institutions attract the very best students. The students want to be taught by the very best and work in state-of-the-art*

labs. I would venture that given a choice, any student would choose being taught by a technical leader in the field instead of someone who has won all the teaching awards but is mediocre technically." (#70, 2002). Another faculty states "*Students want to be taught by world-class experts and world-class experts enhance teaching through their research." (#93, 1999*). These comments indicate a belief that subject knowledge is all that is needed to be a great teacher, which are supportive of the content-focused notion of the importance of "covering the syllabus" expressed by a 1997 respondent, *"I feel that we need to encourage nontraditional methods but not at the expense of content." (#21, 1997).* Faculty with this perspective are conscious of a trade-off between the efficiency of lecture-based methods and the effectiveness of other methods, but do not value the improved learning outcomes offered by the latter.

Faculty awareness of and pressure to use student-centered methods increased. Particularly in the later surveys, faculty comments indicate an increasing awareness of and even pressure to use student-centered teaching methods. *"I think the emphasis on group work, active learning, multimedia, etc. is misplaced and often a detriment to giving our students a quality education." (#54, 1999).* Another comment "*So much time is spent on activities in class that far too little real new material is presented. Please remember, a professor should profess – pass on knowledge to their students. Much of today's classroom activities should be done by students on their own, not in the classroom. When this university decides to award a diploma to a team of students, then I will consider team work important. At present, teamwork is used to coddle students." (#333, 2002*). This

professor thinks that teamwork is not an effective teaching approach despite much research that shows teamwork is much more effective for deeper learning of the material.

This is in contrast to the 1997 administration, in which active learning was not mentioned in the comments. Another faculty member in 1999 also seemed to respond to pressure to adopt new methods—in this case, to adopt certain kinds of educational technology. *"There is more than one method for successful teaching… I believe in person-to-person teaching and not in computer teaching." (#81, 1999).* By 2002, more extensive use of pedagogical terms such as "active learning" and "cooperative learning" is evident. Some faculty in 2002 were confident enough in their grasp of nontraditional teaching methods to recommend changes to the design of the survey: *"I take issue with your use of "active learning" for a particular teaching technique. However we teach, active learning is the ONLY real learning there is." (#107, 2002).*

These findings taken collectively suggest some interesting lines of inquiry. While the comments indicate that there is still a negative institutional culture as modeled by administrators with respect to teaching, the faculty are developing an awareness of nontraditional teaching methods and even, in some cases, passionate reactions to them—both positive and negative. This is consistent with the first of the subculture groups identified in Serow's work—it may be that one of the Coalition's achievements was helping such a community to form.

Climate Analysis in 2014. The data was grouped into quadrants as shown in *Table 4.15*. Quadrant 1 included faculty reporting that they use nontraditional teaching techniques and have a supportive environment for nontraditional teaching. Faculty in Quadrant 2 use nontraditional teaching methods in a non-supportive environment. Faculty in Quadrant 3 use traditional teaching techniques even though they are in a supportive environment for quality teaching, and faculty in Quadrant 4 use traditional teaching in an environment that is non-supportive for quality teaching.

Table 4.15: This table shows the quadrants of the faculty's teaching techniques and environments.

	Supportive Environment	Non-supportive Environment
Non-traditional Teaching	**Quadrant 1**: Non-traditional Teaching & Supportive Environment	**Quadrant 2**: Non-traditional Teaching & Non-supportive Environment
Traditional Teaching	**Quadrant 3**: Traditional Teaching & Supportive Environment	**Quadrant 4**: Traditional Teaching & Non-supportive Environment

The researchers collected 97 surveys, but only 77 survey responses could be classified into one of these quadrants, and 48 percent (37 comments) of them gave comments at the end of the survey. Those that could not be classified included those who responded N/A or neutral scale responses (scores of 3, 4, or 5 on the 7-point scale). Quadrant 1 included 10 percent of respondents, Quadrant 2 had 22 percent, Quadrant 3 had 52 percent, and Quadrant 4 had 16 percent.

Quadrant One: Non-traditional Teaching & Supportive Environment

The first quadrant is the faculty that reported using non-traditional teaching techniques, specifically reporting putting students into small groups for most of the class period to answer questions or solve problems, require students to work in teams (2 or more) to complete homework, giving writing assignments (and exercise that requires verbal explanations and not just calculations), and they did not lecture for most of the class period or assign homework to individuals (as opposed to teams). This was the smallest group, perhaps because it is harder to find an engineering department that supports quality teaching and does non-traditional teaching techniques in their classrooms. This faculty shares their institutional support comes from their department and department chair: "*I think the department values the quality of teaching in undergrad classes but the Dean's actions re rewarding research disproportionately to teaching puts the dept at odds with the Dean in this area" (#97, 2014).*

Even though these professors are reporting a supportive environment in the survey, they still talked about non-supportive environments, such as "*Quality can be improved immediately by… providing time, money, and support staff (true support staff, not administrators) to professors to implement their good ideas…" (#66, 2014)*. This faculty is referring to quality teaching, and is pointing out that quality teaching is not rewarded but this faculty views quality teaching as a personal commitment to students and feels that they are getting support from the institution in other ways "*It's valued, just not explicitly rewarded. This does not impact my choices about teaching - I have my own goals, and I try to reach them" (#72, 2014)*. Other faculty shares that quality teaching

does not help them get promoted, "*While it's impact on promotion and tenure is still slight, the emphasis is growing" (#94, 2014)*.

Quadrant Two**: **Non-traditional Teaching & Non-supportive Environment.

Quadrant two captures the faculty that are reporting non-traditional teaching and non-supportive institutional support. Every comment that was collected in this group said something about not being supported by the department, department head, or top administrators. The way this was coded in the survey suggests that the faculty felt strongly the lack of support from at least two of the four options, which were colleagues, department head, your dean, or top administrators. The faculty had the option to rate each one either low (not important) to high (extremely important) and were given an option to not report (N/A).

Department Head: One faculty said "*This is too tightly coupled to the Heads. Engagement with UGs in the classroom is not a high priority for my Head compared to research productivity, so the quality of the experience for our students is left to the intrinsic drive of the faculty.*" *(#90, 2014)*. This faculty says that there is a lack of support from the head of their department, *"We are a research institution and I have been personally been told by the Head of our School, XXX, that the research is the most important aspect for promotion. You can be promoted on researching the work of others but not doing it. That view is not held at higher administration, like the Dean and University who value teaching more" (#92, 2014)*. The latter faculty reported a low score for the colleagues and the head of the department, and high scores for the dean and top

administrator. The perception of the department head's attitude toward quality teaching and colleagues is not supportive of quality teaching.

Colleagues: Another faculty in this quadrant explains why they think their fellow colleagues are not focused on quality teaching, but gives colleagues and department head a higher score than dean or top administrator: "*My department includes faculty who are deeply concerned about undergraduate student learning, some of whom still engage in practices that run counter to their values for various reasons. One common reason is that they have been overwhelmed by the high research expectations of the institution, which are more frequently and more loudly voiced than the institution's expectations regarding teaching, even if those expectations are well-intentioned. Another reason is that the myriad demands on faculty time can make faculty time-management a frantic activity that lacks focus outside of the development of a research program. Others in the department are either hyper-focused on research for its own sake, or they prefer to devote their energies to graduate education. For some, it is the smaller class size and greater control over content and assessment that makes graduate education more appealing, for others, it is the more intimate relationship that results from working with students who are more like colleagues. For others, it is the maturity of the graduate students. Although I mentor graduate students, I teach exclusively undergraduate classes and seek to develop academic relationships that will have an impact on their lives" (#95, 2014)*. Another faculty talks about their colleagues saying: "*Most faculty care deeply about teaching, but there are strong disincentives to spending more than minimal time on it. Few faculty have*

a professional attitude towards teaching in terms of seeking to improve their teaching systematically" (#56, 2014).

Dean: A faculty explains that their dean has had a negative impact on the climate for quality teaching: "*For our college, it is dismal. Our Dean is contemptuous of teaching and only cares about research and rankings. Over the years he has inculcated an atmosphere consistent with his disdain for teaching. Respect for teaching is currently at its lowest ebb in my career" (#29, 2014)*.

Quadrant Three**: **Traditional Teaching & Supportive Environment.

Quadrant three could be mistakenly characterized as an environment that is supportive of faculty teaching, but not quality teaching. The survey asked "How important is teaching *quality* to each of the following…", in which teaching quality could be interpreted differently to different people (Harvey & Green, 1993). The definition of teaching quality was clarified: "Setting high but attainable standards for learning, enabling most students to meet or exceed those standards, and producing high levels of satisfaction and self-confidence in the students." Over half of the faculty were in this quadrant, reporting that they were using traditional teaching techniques and were in a supportive environment for quality teaching.

Passionate teaching: Many faculty in this quadrant reported being passionate about teaching, although their teaching techniques were reported as traditional: *"Although there are few real incentives to do a great job teaching, many of us have a personal mission to*

do a great job teaching and take great satisfaction from educating and motivating our students and helping them reach their educational and career goals" (#14, 2014).

Faculty are feeling the pressure to not use traditional teaching, such as lecture-style teaching techniques. Some faculty think that a traditional lecture-style teaching is still the best way to teach: *"I have observed an increase use of active learning and moderated group discussions in class. While these appear to be more engaging learning experiences, they are being overused. A course needs a balance of both formal lectures and in-class learning exercise. Right now, there is an emerging climate that formal lectures are taboo. While prepared lectures with relevant content to the students are still a highly successful means of education. I have received over 4 teaching awards in my career and my teaching evaluations are consistently in the 90th percentile, and I still use a good number of formal lectures throughout my courses, but even to this day they take time to prepare" (#21, 2014).*

Evaluations: In the previous comments from the surveys collected in 1997, 1999, and 2002, there was a decrease in the negative comments about student evaluations, but there seems to be more concern about student evaluations now. This could be because these are faculty from different schools, or that in the past 12 years there has been an increased concern. Faculty point out the student evaluations are not helping to maintain quality teaching, but rather forcing professors to give out "easy As": "*I feel that grade inflation is severe, such that those faculty who do not give out an easy A will get lower evaluations. And evaluations are taken into account for tenure and promotion, so therefore faculty will do what is necessary to make the students happy; which has led to grade inflation.*

I believe I have observed this during my 17 years at the university, where courses have become considerably easier, and student complaining about not getting an A has increased. Perhaps this is due to the tight job market, where grades are becoming increasingly important to students. But grade inflation hurts the top students, who will no longer stand out as being better. Therefore, it would be best to only use evaluations in a personal manner, as constructive feedback, and not in a punitive manner, which hurts both faculty and the top students. It also depends on the course that is taught, and expectations of the students, and for some reason, gender of the faculty (where woman are expected to be easier in grading)" (#40, 2014). Another faculty is concerned about what the student evaluations are actually measuring: *"Quality of teaching cannot be measured with end of semester evaluations. So at this point in time, we have not implemented ways of measuring the quality of teaching by individual faculty. Therefore, I would say it is not important. We need to stop assuming "popularity surveys" are the same as "quality of teaching"" (#68, 2014)*. These faculty seem to not be aware of significant evidence that student evaluations of teaching correlate well with teaching effectiveness (Felder, 1992).

Supportive Environment: One faculty talks about the supportive environment: *"Very strong department in supporting new ideas to test in the classroom (which is great, because that's what I've always done to try to improve the experience)" (#18, 2014)*. This next faculty only talks about the environment, and excludes personal experience: "*more teachers are interested in teaching well... more teachers are willing to change how they teach... more are willing to be reflective about what they do in the classroom.*

Things are getting better" (#22, 2014). One faculty admits that they are in a different environment than their peers at another campus, which puts them in a position to teach with less pressure from colleagues or upper administration to fit in or teach counter to their beliefs: "*I don't teach at the main campus, but in a partnership program at another university (XXX). As a result, I teach in a very different environment than that of my employing institution. I have very small class sizes and am able to do far more hands-on work with my students" (#51, 2014)*. One faculty says the overall environment is not supportive to quality teaching: *"I taught (as staff) for 7 years before becoming faculty. It is my impression that the focus on quality teaching (which was always much, much lower than on research funding and publications) has only continues to decrease throughout the years. I do not feel encouraged to teach to my best ability, but rather to try this, or try that, or metric this, or rubric that. As I read about other campuses, I see that I am not alone in this perspective. If the mission of a University is teaching, then we need to do better. If the mission is NOT teaching, then we need to stop lying to ourselves and our students" (#91, 2014)*.

Administration: Many faculty see top administrators working against them, rather than helping make quality teaching happen in the classrooms. This particular faculty rated their colleagues and department head very high for being supportive, and reported using traditional teaching techniques: "*Too many faculty enter academia for reasons other than to teach (e.g. research, administration). They seem to either enjoy teaching or view it as a burden. It is hard work in either case. Few are the faculty that can strike a good balance between the myriad of responsibilities they have.*

Over my 40 years of teaching in a variety of settings I have seen the bureaucracy (administration) grow uncontrolled while adding nothing to the quality of teaching. Indeed it often detracts from our commitment to our students -wasting our time "bean counting" to prove some "innovative" pet program or to justify our jobs to administrators. A good example of this is "effort reporting" instituted here over the past few years. It is insulting for the administration to waste our time by demanding useless paperwork from those who work so hard to educate our youngsters. We pay our administrators to make our job easier when in reality they do the opposite" (#36, 2014). The next quote shows that individual faculty have a personal commitment to teaching, and are getting lip-service from the administration, which was reported often in 1997, 1999, and 2002: *"Teaching remains very important to most faculty. This is fortunate, because it is of decreasing functional importance to school administration. While everyone feels compelled to _say_ that they value teaching, measures of financial and facilities support reveal its ever decreasing importance in the eyes of administration. This is very unfortunate" (#77, 2014)*.

Quadrant Four: Traditional Teaching & Non-supportive Environment

Quadrant four contains faculty that reported traditional teaching techniques and a non-supportive environment for quality teaching. Faculty in this group could be reporting their lack of support for the teaching methods they are using. There were very few comments from this group, but the faculty that did comment shared about the non-supportive environment, and the comment that follows is telling of the faculty's views of quality teaching:

"Our campus does not care in the least bit how much students learn in a course and simply care about the student evaluations which lead to easy classes and graduates with poor knowledge. The easiest way to get a good evaluation is to make students think they have learned a lot through assignments and tests that very closely correlate to HW and in class examples. This approach while rewarded at the university does not teach the students problem solving or challenge their capabilities to maximize knowledge transfer (my def. of quality teaching)" (#6, 2014). Alignment of homework, quizzes, and exams are considered good in non-traditional teaching because there is more clarity of what the students are learning with clear, straight forward quizzes and exams that test the knowledge gained.

Lip service was a common theme in each of the previous surveys from 1997, 1999, and 2002 and shows up in the comments from 2014 as well: *"Lip service given, but resources to support teaching continue to be cut" (#8, 2014)*. The next faculty sees lip service having contributed to these different metrics of self-satisfaction: *"Teaching has always been given a lot of lip service, but the interesting thing is that of late it appears there really is interest in it but with different metrics. The main change is from technical competence to self-satisfaction. The level of competence has declined dramatically, it is very evident and could be measured if there was interest. It is a very serious problem" (#89, 2014)*. This faculty remains concerned about content even though surveys of employers typically indicate that students' technical skills are adequate, whereas there is greater need to improve students' professional skills.

4.5 Conclusions

While these comments show diversity of beliefs about how the university is acknowledging the quality and importance of teaching on campus, the climate does have an effect on the faculty's pedagogical decisions. The comments reported above from 1997, 1999, and 2002 show a shift in faculty's perspective of the quality and importance of quality teaching through the changes seen in their comments on student evaluations. In 1997, there were many negative comments about student evaluations, and by 2002, there were only two negative comments, and the other two comments were positive. It is encouraging that such a change in attitude could be effected in only five years, even though his research cannot attribute that change to the SUCCEED Coalition or its programs. While it is challenging to compare the comments from earlier administrations to the comments in 2014 because two-thirds of the comments were from different institutions, the continued use in 2014 of the term "lip-service" that was prevalent in the earlier administrations is further evidence that some aspects of the culture are resistant to change. Faculty from Purdue University in the COACHE survey report the need for more clarity from administration in the expectations for tenure and promotion policies (McClure, 2012), which is along the same lines as some of these research findings.

The conclusions from the 2014 survey results were compelling. Very few faculty that feel they are in an environment that is supportive of the non-traditional pedagogies they use. Faculty using non-traditional methods are aware of the lack of support and articulate how uncomfortable the climate is for their choice in pedagogy. Other research shows that science, technology, engineering, and mathematics (STEM) faculty are the least likely

from higher education to use student-centered teaching methods (Eagan, et.al., 2014). The many faculty using traditional methods in where that is consistent with the climate for teaching are defensive about their choice in pedagogy, expressing strong beliefs that traditional teaching methods are still the best way to teach. They accused the administration of changing metrics capriciously, so they feel some administrative pressure to change. The faculty in the most uncomfortable position were those continuing to use traditional methods, even though the climate was supportive of a transition to non-traditional methods. It is not clear whether they do not feel like they are being supported because they are using traditional teaching techniques or because it is a poor fit for them with the department and institution. All groups of respondents had some complaints about the administration, although they did not use the term lip service as often as the 1997, 1999, and 2002 group did. There is tension between the climate at the institution and faculty's choice of pedagogy that was shown through the comments in 2014.

Identifying changes in faculty's perception of the quality and importance of teaching may help engineering education researchers better understand the process of change and its time constant, and perhaps how to foster further change in the attitudes and practices of engineering faculty with respect to non-traditional pedagogies. This understanding should be of particular value in the development and implementation of faculty development programs. Faculty development programs need to understand institution-specific and department-specific climate concerns to understand and help develop faculty's skills as educators. Faculty in this research all received the same survey, and many chose to write in the last comment box about the climate for teaching quality at their institution.

This is an indication the climate is foremost in the minds of many faculty as they consider what pedagogy to use in their classrooms. Faculty developers and researchers should consider looking at the development of the institutional and departmental climate for teaching quality, where they can build a supportive environment around quality teaching. This might suggest development workshops for institutional and departmental leadership and institution-level incentives to encourage a positive climate. More research is needed to see how an effective faculty development program can create systemic change within an institution or department for the use of higher quality teaching.

CHAPTER 5. CONCLUSIONS

5.1 What We Learned From Each of the Research Studies

From ***Engineering Faculty Perspectives on the Nature of Quality Teaching***, we find that engineering faculty have diverse definitions of quality, but some definitions that have been identified previously were not prevalent among engineering faculty. Exceptionality was the most common view of the nature of quality (43 percent), which leads faculty to adopt passive approaches to learning. A transformational definition also common (28 percent), focusing student development and richer outcomes, leading faculty to student-centered learning approaches. The view of quality as fitness for purpose (24 percent) was characterized by language tying the learning objectives to the course content, making sure students are prepared for the job market or another class, and or focused on preparing students for the profession.

The Influence of ABET Accreditation Practices on Faculty Approaches to Teaching shows us that while ABET seeks to promote quality and innovation in education, most faculty describe the accreditation as having a negative impact in general, and many of the negative comments were specifically about ABET having a negative effect on faculty teaching quality. Faculty attitudes about accreditation

processes were related to their teaching methods. In general, if faculty attitudes about ABET were positive, then they were more likely to use student-centered teaching methods, whereas if their view of ABET was negative, then they were more likely to use traditional, lecture-based teaching methods.

Faculty Perspectives and Institutional Climate for Teaching Quality in Engineering was an exploration of faculty's comments about teaching quality in multiple survey administrations and specific views about what faculty were doing in their classrooms. Historical data from 1997, 1999, and 2002 showed that faculty opinions of student evaluations evolved from seeing it as a negative burden to describing is as positive evidence of student learning. Faculty comments included many references to administrators who only "pay lip service" to the importance of teaching. This perspective persisted through all survey administrations, although there was some reduction in the prevalence of this over subsequent administrations. Faculty awareness of and pressure to use student-centered methods increased with time.

The collective case study identified faculty in all four conditions, although they were not equally prevalent, and illustrates the experience in each condition using faculty comments. Data from 2014 was used to determine if faculty had either supportive or non-supportive teaching climate and whether the faculty member used traditional or non-traditional teaching methods. Quadrant One included faculty using non-traditional teaching in a supportive environment, and described various expressions of support in their comments. Quadrant Four included faculty using traditional teaching

in non-supportive environments, and they provided dire comments describing this lack of support, which seemed to foreclose any attempt to use better teaching methods. Quadrant Two included faculty using nontraditional teaching methods in a non-supportive environment, reporting various challenges—colleagues, department chair, Dean. Quadrant Three, characterized by faculty using traditional teaching methods in an environment supportive for non-traditions methods. These faculty comments described various consequences of the mismatch, but were not consistent with a single theme.

5.2 What We Learned From All the Studies Taken Together

This dissertation explored engineering faculty's thoughts and opinions on quality teaching. They have a variety of different avenues to get support for quality teaching, and this dissertation attempted to gain an understanding through a survey about a couple of them, mainly faculty's own thoughts about the nature of quality, ABET as a source for quality teaching, and whether institutional climate had an effect on teaching quality. There are other options that faculty could be using to help them succeed at quality teaching, like a campus teaching institute, which was not explored in this dissertation, although faculty did have the option to report anything they wanted, the researchers specifically targeted faculty's intrinsic motivation, ABET accreditation, and institutional climate. The nature of quality that engineering faculty are defining quality teaching shows their thoughts on ABET as not supportive for quality teaching. Engineering faculty generally did not see ABET, or any other external driver, as a support or ally in their quest for teaching quality.

Institutional climate can play a part in how faculty look at quality teaching. Faculty that had reported using nontraditional teaching methods and reported being in a non-supportive environment consistently commented about the non-supportive environment. Faculty views of ABET could play a role in the department or institutional climate that affect how faculty see their environments—certainly, faculty comments about accreditation processes showed strong agreement that the current implementation has significant negative consequences. ABET was related to faculty teaching methods, but did not seem to have an effect on whether faculty felt they were in a supportive environment—possibly because faculty perceptions were so negative that there was not enough variability to see a relationship.

The nature of quality that faculty use to assess their teaching overlaps with their teaching and institutional environment. There may be unexplored direct relationships, but understanding a faculty member's definition of quality teaching could give insight into whether faculty feel they are in a supportive environment at their institution. For example, if a faculty's nature of quality teaching is "fitness for purpose" and their institution's environment of quality teaching is exceptional, this would be a misalignment of nature of qualities that could result in a non-supportive environment.

Faculty views of ABET may align with their views of the nature of quality teaching. Many faculty thought that ABET was using more resources of time and money that faculty did not think was worth the time and money, as these faculty may have the view of the nature of quality teaching as exceptional or transformative, which was the

majority of faculty in these studies. Faculty that saw the nature of quality teaching as fitness for purpose have a closer alignment with ABET accreditation, as their purpose for teaching specific materials align with an ABET accreditation outcome, and therefore they meet their own value of quality teaching. Both of these studies could inform the other in faculty's value of quality and how this affects their views of accreditation and their teaching methods.

5.3 What Seems Likely After Having Completed All Three Studies

Institutions with supportive teaching environments may not be challenging faculty who teach traditionally to change their teaching styles, but are providing critical support for those using non-traditional methods. Departments and institutions would do better at developing faculty if administrators were aware of the different views of quality teaching present in their faculty. To the extent that some students may resonate with different definitions of quality, there may be a case for seeking faculty with diverse definitions. This particularly raises the value of open discussion of these differences so that faculty and their students understand the decisions being made. Adding faculty with a "fitness for purpose" or "transformative" definition would gain from a more diverse perspective. The different perspectives on the nature of quality teaching might all benefit an engineering program, in having a better understanding of colleagues and a department head and making sure that a degree program is addressing more than just one definition of quality. Similarly, addressing these different types of quality might appeal to different employers.

The goal of this dissertation was to gain insight into the thinking behind quality teaching for engineering faculty, either why they disregard it or why they are passionate about it. From this research, it is clear that most of the engineering faculty that responded to this survey care about quality teaching because they care about the work they do as an educator, but the lack of consensus on what quality means leads to a lack of consensus on the best approach to teaching. The faculty comments described negative feelings about exasperation, frustration, and workload, but also included assertions of the ideals they strive for such as integrity, respect, kindness, and hard-work for the students they educate.

Future work will include analyzing the comments from the SUCCEED survey results in 1997, 1999, and 2002 with the quadrants of combining the teaching method with the climate to see if there is a pattern over time.

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VITA

VITA

Jacqueline C. McNeil

Purdue University, Neil Armstrong Hall of Engineering
Room 1300, 701 W. Stadium Avenue
West Lafayette, IN 47907-2016

CAREER OBJECTIVE

Seeking a dynamic and challenging position in an institution that is working to improve quality of life through research, education, and institutional infrastructure.

EDUCATION

Doctor of Philosophy August 2011-Present
Engineering Education, GPA 3.7/4.0
Purdue University, West Lafayette, Indiana

Master of Science August 2011
Engineering Management, GPA 3.9/4.0
Tiospaye in Engineering and Science: Inculcating a Sustained Culture for Recruiting, Retaining, and Graduating American Indian Students
South Dakota School of Mines, Rapid City, SD

Bachelor of Science August 2007
Mining Engineering, GPA 3.1/4.0
Feasibility Study of an Underground Limestone Mine
South Dakota School of Mines, Rapid City, SD

RESEARCH

Purdue University, West Lafayette, Indiana

Faculty Perceptions of Quality Teaching Summer 2013-Present
Research includes writing a proposal to NSF for a grant to support the work. The research assessed participation in faculty development programs, student-centered teaching methods, and other practices and factors that impact faculty pedagogy choice, particularly institutional and departmental climate, accreditation, and tenure and promotion processes. Qualitative data were collected on faculty definitions of quality teaching and the effect of accreditation on their teaching.

Nontraditional Students in Engineering Summer 2013-Present
Research studies the pathways of nontraditional students in undergraduate engineering using the MIDFIELD database, exploring outcomes related to access, performance, and graduation. This work is funded by NSF grant 1361058 for $293,969 and began in March 2014 with a three-year duration. This grant will transfer into my control as the PI when I start a faculty position.

Concept Inventories Spring 2012-Spring 2013
Assisted with workshops on concept inventories and the ciHUB, research includes professional development, faculty change, innovative teaching, and factors that impact faculty pedagogy choice.

South Dakota School of Mines, Rapid City, SD

American Indian STEM 2009-2011
Ran, evaluated, and revised program to improve American Indian retention in STEM degrees. Mentored and tutored students, created a source of support for achievement in academic settings.

TEACHING

Purdue University, West Lafayette, Indiana

ENGR 142 Honors Engineering Design II Spring 2014
Teaching Apprentice for the second semester first year engineering honors program at Purdue University. Involved in the educational design of the class, taught some lessons, member of the teaching team, attended weekly meetings on class design, mentored by engineering education professors.

South Dakota School of Mines, Rapid City, South Dakota

Mentor/Tutor, Tiospaye in Engineering and Science 2009- 2011
Facilitated recitation sessions in College Algebra, Calculus 1 and 2, Chemistry 1, Physics, Statics; Tutored; Instilled time management practices, mentored 35 American Indian students pursuing engineering and science degrees

AWARDS

Purdue University, West Lafayette, Indiana

- Nontraditional Student NSF Grant, Spring 2014-present
- Engineering Education Outstanding Service Award, Spring 2014

South Dakota School of Mines, Rapid City, South Dakota

- WAAIME Scholarship 2005-2007
- Society of Mining Engineers National Scholarship 2006
- Buckskin Mining Scholarship, 2005

PUBLICATIONS

- McNeil, J., Ohland, M., Brawner, C., An Examination of the Climate for Quality Teaching in Engineering, Frontiers in Education Conference, Madrid, Spain, October 2014.
- McNeil, J., Ohland, M., Long, R., Getting Better with Age: Older Students Achieve Higher Grades and Graduation Rates, Frontiers in Education Conference, Madrid, Spain, October 2014.
- McNeil, J., Ohland, M., Long, R., Nontraditional student access and success in engineering, American Society of Engineering Education Conference, Indianapolis, IN, June 2014.
- McNeil, J., Kerk, C., Kellogg, S., Tiospaye in engineering and science: Inculcating a sustained culture for recruiting, retaining, and graduating American Indian students, Frontiers in Education Conference 2011, Rapid City, SD, October 2011.

PRESENTATIONS

- An Examination of the Climate for Quality Teaching in Engineering, Frontiers in Education Conference, Madrid, Spain, October 2014.
- Older Students Achieve Higher Grades and Graduation Rates, Frontiers in Education Conference, Madrid, Spain, October 2014.
- Nontraditional student access and success in engineering, American Society of Engineering Education Conference, Indianapolis, IN, June 2014
- Faculty and Concept Inventories: Measuring Change and Openness to Change, ciHUB National Meeting, Washington, DC, August 2012
- Workshop: Tools to Facilitate Teaching and Learning in the First and Second Year of Engineering: Concept Inventories, ASEE Conference 2012, San Antonio, TX, June 2012
- Tiospaye in Engineering and Science: Inculcating a Sustained Culture for Recruiting, Retaining, and Graduating American Indian Students, Frontiers in Education Conference 2011, Rapid City, SD, October 2011

VOLUNTEERING & SERVICE

- President for Engineering Education Government Student Association at Purdue University, 2013-2014
- Faculty Search Committee at Purdue University, 2013-2014
- Treasurer for Engineering Education Government Student Association at Purdue University, 2012-2013
- Treasurer for the American Society of Engineering Education (ASEE) Student Chapter at Purdue University, 2012-2013
- Women in Engineering Summer Program, 2013
- Women in Engineering; Mentor for 7th and 8th grade girls spending a day at Purdue, February, 2012
- Secretary of Society of Mining Engineers Student Chapter at South Dakota School of Mines & Technology, 2005-2006

PROFESSIONAL MEMBERSHIPS & AFFILIATIONS

- Member of Engineering Education Graduate Student Association (ENEGSA)
- Member of American Society of Engineering Education
- Member of Women in Engineering Program at Purdue University
- Member of Society of Mining Engineers (2006-2008)

EMPLOYMENT HISTORY

Purdue University, ***West Lafayette, IN***
Research Assistant August 2011-present

- Leader in proposal written to investigate nontraditional students within the MIDFEILD database. Conducted and wrote a literature review of nontraditional students in engineering and identified research gaps. Continue to organize and investigate this research project.
- Leader in proposal written to do research on faculty teaching practices. Investigated barriers to faculty change, engineering faculty teaching practices, engineering faculty definitions of quality teaching, and barriers to choice in pedagogy. Writing my dissertation on this research topic.

South Dakota School of Mines & Technology, ***Rapid City, SD***
Mentor and Tutor September 2009-May 2011

- Facilitated mentoring and tutoring for American Indian students. Arranged group tutoring within subjects of calculus I and II, college algebra, chemistry, physics, and statics.
- Mentored first generation college students on expectations, time management, living arrangements, clothing issues, financial problems, drug and alcohol dependencies, and transportation issues.

Wyodak Resources Development Corporation, ***Gillette, WY***
Mining Engineer June 2007-July 2009

- Short term mine planner, create weekly, monthly and quarterly plans for production supervisors, calculate 3D volumes (AutoCAD) for placement and removal, pit-haul road design and post-mining reclamation design.
- Provide daily operational review and quality control of inventory for customers. Responsible for the product quality for the train contract, blend product to meet those requirements, and schedule trains on site for loading.
- Responsible for feasibility studies for ramps, roads, water drainage, dump designs and volumes. Implement road and ramp designs that are useful and effective for state and federal regulations.
- Assist surveyor with GPS and staking drill holes, new haul roads, the dump design and coal inventory.
- Manage the bid-letting process for numerous projects on site; Complete remodel of Wash Bay building, reclamation projects, and the movement of topsoil

Wharf Resources, *Lead, SD*
Mining Engineer Intern May 2006-August 2006

- Supervise an exploratory drilling project contracting two drilling rigs and maintaining good working relationships with each one throughout the project.
- Implement the design of the exploratory drill holes, researched where the holes would identify mineralized areas, responsible for the crews drilling the right angle, depth, and location.
- Identify mineralized areas through recognition of different rock types, analyzed data, took responsibility for the assays and organization of all the samples, imported all the data into GemCom computer software program.

Buckskin Mining Company, *Gillette, WY*
Mining Engineer Intern May 2005-August 2005

- Create a Spill Prevention Plan for containments on site, create maps for each location and an explanation of how the company was complying with each law.
- Assist with mapping for permitting purposes, using AutoCAD and MineScape for these maps, and organize the maps that were generated from the project.
- Research and establish a drilling layout for exploratory drilling onsite.