Engineering Education: Studying Faculty Perceptions of Male/Female Students in Their Classroom

Janaki Perera & Brendan Quinlivan
Advisor: Professor Yevgeniya Zastavker
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Project Overview

We initially began our Capstone project intending to examine faculty member's confidence in their teaching practices using Grounded Theory Method. To begin we read through 19 faculty interview from a larger study for general trends. After this initial read through, we drafted a codebook, which included a series of codes for the general trends apparent throughout the interviews. These 'codes' were later used to tag portions of the interviews that were relevant to each code. After this initial codebook was drafted it was modified through a process of open coding, in which we altered our definitions of codes based on what we saw during our first pass of coding. After achieving an intercoder-reliability rating of 85% with this revised codebook (found in Appendix A), we proceeded to code all of the faculty interviews.

When examining the coded quotes we discovered emergent themes which we had not initially intended to examine, including several emergent themes center around gender. Additionally, we found that our initial direction, faculty confidence, was not as compelling to us as researchers as some of the themes which we were finding. At this point in our process we were also reading Glaser and Strauss to strengthen our understanding of Grounded Theory Method, specifically focusing on the constant comparative method of analysis (Glaser & Strauss, 1967). Our exploration of the constant comparative method lead us to re-examine our own process, and also reaffirmed our belief that we should not continue pursuing faculty confidence if our findings did not seem substantial, and should instead focus on the themes that were naturally emerging from the interviews, specifically faculty perceptions of male/female students and faculty.

We began this new study by first identifying all the gender related portions of the interviews with an extremely simple codebook (see Appendix B). With this codebook we separated out all direct mentions of gender in interviews, including any use of gender specific personal pronouns when talking about students or faculty, any references to specific students or faculty with implied gender, and any generalizations about males or females. While identifying these quotes, we began writing memos of trends that we observed throughout each interview. Once we completed coding and memo writing for all the interviews, we examined all of the memos as a whole, and began identifying specific themes across interviews. From these themes we developed our third codebook (see Appendix C) focusing specifically on faculty perceptions of male/female students in their classroom.

Similar to our investigation of faculty members' confidence, we went through a process of open coding and eventually achieved an intercoder reliability rating of 95%. We then proceeded to code, memo, and analyze all the interviews.

Below is an example rough draft of a paper on this work which would have to be significantly modified upon completion of the future work section.

Abstract

For this project faculty perceptions of male/female students in their classroom were investigated. To do this grounded theory method was used to code and analyze 19 interviews with faculty members teaching introductory physics, mathematics, and engineering courses across three different small technical institutions. The results of our preliminary analysis found four groups of faculty members based on their gender related contingency, or how faculty members modified their teaching practices or classroom environment based on the differences they observe in male and female students. These four groups of faculty members were: *Interventionists*, *Behavior Modifiers*, *Procedure Modifiers*, and *Non Modifiers*. A preliminary investigation into the characteristics of these four groups was conducted and a deeper investigation of the characteristics is proposed.

Introduction

Given the changing concerns of the 21st century, there is an increasing demand for STEM graduates (Langdon *et al.,* 2011). The high attrition rate of STEM majors is a longstanding problem in the United States (Langdon *et al.,* 2011; Casey 2012). Additionally, the attrition rate of female STEM majors has been consistently higher than that of male STEM majors (Darby, 2011). Studies attempting to understand the reasons for this attrition divide have examined factors which contribute to the departure of those students who leave STEM programs and to the success of those women who do persist in STEM majors. Departure from STEM majors takes place primarily within the first two years of an undergraduate program (Brainard *et al.*, 1995). Of those students departing from STEM majors in their first year, low levels of confidence are frequently reported as a factor contributing to their departure (Brainard & Carlin, 1997; Seymour & Hewitt, 1997). Results show that many of the women who persist in STEM majors through their first year felt that they had been positively influenced by faculty support, and strong relationships with faculty members (Brainard & Carlin, 1997).

Thus in order to learn more about this presence of faculty support that has been found to be important in the retention of female STEM majors this investigation aims to explore faculty members perceptions of male and female students in their classroom. A framework is proposed relating instructors' gender related contingency to their affect towards male/female students and their perception of the similarities and differences between male and female students.

Methods

This investigation is part of a larger mixed-methods study which focuses on the first-year engineering undergraduate student experience at three small, technical colleges/universities. The data for this larger study includes interview with faculty members and first-year students, classroom observations, as well as student surveys.

This investigation focuses on nineteen semi-structured, open-ended interviews with faculty members and lab instructors (7 women and 12 men) conducted at three small, technical undergraduate institutions. These interviews were conducted with faculty members and lab instructors who teach first-year students in mathematics (6 faculty), physics (7 faculty), and

engineering (6 faculty) courses. Grounded theory was utilized in this study to analyze these faculty interviews (Glaser & Strauss, 1967; Strauss & Corbin, 1998).

For data analysis, a process of substantive coding was used where codes, or classifications of the content of the quote, were assigned to individual quotes and continually revised as a response to trends discovered within the data. This iterative process was continued until a set of codes, representative of the data trends, was settled upon.

For analytical validity, the consistency between individuals in using these final codes was evaluated by calculating the "inter-coder reliability," a quantification of the agreement between the two coders (Raffle, 2006). Once an inter-coder reliability value of 95% was achieved, analysis was continued by completing the coding of all of the faculty interviews. The quotes were then organized into matrices based on codes and emergent themes were identified through the analysis of these matrices (Strauss and Corbin, 1994). The relationships between these emergent themes were mapped and from this a preliminary theoretical framework was developed.

Emergent Themes
Based upon the coding and analysis of the 19 interviews, emergent themes were discovered within each of the following four codes.

Gender Contingency
The *Gender Contingency code* focused on '*any mention of treating students differently or treating students the same in relation to their gender*'. Below are two example quotes that would be included in the *Gender Contingency* code:

> *...I think gender dynamic wise the class is going very well. …I have been watching out for the signs of losing female students, losing interaction and such, and I haven't been seeing them so far until the mid-terms.*
>
> Anna Samuels, Physics Faculty

> *Of the students who are struggling with programming the majority are female. When they work in pairs ...our female students often work with other female students and our male students often work with other male students. What that means is that we often have pairs that consist of two female students who have not programmed before and that usually doesn't work very well. So we try to break up those students.*
>
> Ted Branson, Physics Faculty

When analyzing this code three distinct forms of gender-contingency were found. These faculty were classified, based on their contingency, into four distinct groups: *Interventionists*, *Behavior Modifiers*, *Procedure Modifiers*, and *Non Modifiers.* Additionally, faculty seemed to either adopt a proactive or a reactive approach when adjusting their teaching. In a proactive approach faculty were attempting to address possible gender-related difficulties before they arose, and in a reactive approach faculty

were adjusting their teaching practices to address gender related differences after they had become an issue in their classroom.

Interventionists attempted to discuss gender related issues with students through a direct intervention. All *Interventionists* were also reactive in their contingency. An example quote from a faculty who used reactive interventions as a form of gender-contingency, referred to as is shown below:

> *I try to get around to every group and I try to make sure I'm not letting one person you know ask all the questions or answer all the questions, and I'm particularly keen on intervening when I see the, you know there's one guy in the group and two girls and he's got the chalk and he's asking all the questions and answering all the questions. So I'll purposefully turn and say Jenny, what do you think of dah-dah-dah and then often times the guy will try to answer and I say nah-nah-nah, and that kind of thing.*
>
> Donald Farns, Physics Faculty

Behavior Modifiers changed their own classroom behavior with students, modifying behaviors such as how they called on students or how they spoke to students. These modifications were both reactive and proactive. An example quote of a faculty who modified their behavior is shown below:

> *I try to not exclusively let the men dominate or exclusively let the women dominate. I have another example I do in class, it's an example of proof by contradiction and I need two volunteers. I always make sure there's a male and a woman volunteer. Even though probably two men jump up to volunteer... I will tell you that I am actively trying to not be too biased.*
>
> Oliver Jones, Mathematics Faculty

Procedure Modifiers made primarily proactive changes to the actual structure or procedure of the class, such as modifying how groups were formed or how students turned in assignments. An example quote of a faculty who modified their procedure is shown below:

> *We were very aware that there were fewer women in the class and we thought very carefully about doing that. The first teams are assigned randomly, so they just are the way they are. But we were very careful to, as much as we could, put the women on teams where there were two women. So there were fewer women in the class, so we'd have mostly all guy teams and where there were women, there would most often two women and two men.*
>
> Kelly Nole, Engineering Professor

Our final group, *Non Modifiers,* did not alter their classroom behaviors or procedure as a result of gender-related concerns, thus they expressed no gender related contingency.

Affect Towards Male/Female Students

Another code, *Affect Towards Male/Female Students* includes *'any gender specific expression of feelings towards students.'* Below are two example quotes:

> *And I love the women. They are hot tickets which they have to be…*
>
> Diane Troy, Mathematics Instructor

> *I enjoy working with the ones that are excited about doing it, regardless of what they're making. So this girl Rachael, who I explained, you know she was making parts for her project, and she was excited about it. And so that was that was fun.*
>
> Jeffrey Cohen, Engineering Faculty

Through the analysis of this code it was found that faculty members were often showing affect towards either generalized students of a particular gender, or specific students with a known gender. It was found that *Interventionists* and *Structure Modifiers* showed little to no generalized affect, and *Behavior Modifiers* and *Non Modifiers* showed primarily generalized affect.

Similarities between Male/Female Students

Another code, *Similarities,* focused on '*any discussion of the similarities between male and female students or any mentioned of gender's lack of impact.'* Below are two examples quotes that would fall under the *Similarities* code:

> *Male or female at this school they all come with the same stuff. There are kids that are scared of math just because it's math even though they're real good at it.*
>
> Diane Troy, Mathematics Faculty

> *I have an equal number of students who respond to questions male and female, even though I think I have fewer...females than males in the class. I think the females are equally engaged and equally disengaged.*
>
> John Pinkard, Mathematics Faculty

When analyzing this code it was discovered that faculty members who fell into the *Non Modifiers* group called out the similarities between male and female students significantly more than those faculty members in the other three groups.

Attributes and Behaviors of Male/Female Students

The final code in which an emergent theme was found was *Attributes/Behaviors* which focused on '*Any general statements about the differences between male and female students attributes (such as confidence or technical competency) and behaviors (such as speaking up in class or seeking extra help).'* Two example quotes are shown below:

> *Sometimes the confidence level thing...you do see a difference in, where guys are more likely to be oh yeah, I'm good at that, and the woman with the same level of talent or expertise or whatever, says I guess I'm okay, but I don't know.*
>
> Courtney Lars, Engineering Faculty

Women tend to come to office hours more, but I don't know if that's because I'm a woman. I think it's just that's sort of a trend that women are, kind of more insecure and feel like they need the more help and guys think they're fine and don't think that they need the help, so don't come

Kate Beckett, Mathematics Faculty

Within this code it was discovered that faculty members who fell into the *Interventionists*, *Behavior Modifiers*, and *Structure Modifiers* groups called out the attributes and behaviors of male and female students significantly more than those faculty members in the *Non Modifiers* group.

Preliminary Framework

Based on the previous four emergent themes a preliminary framework was developed based on the gender related contingency displayed by each group of faculty. Below is an outline of the preliminary framework developed around gender related contingency.
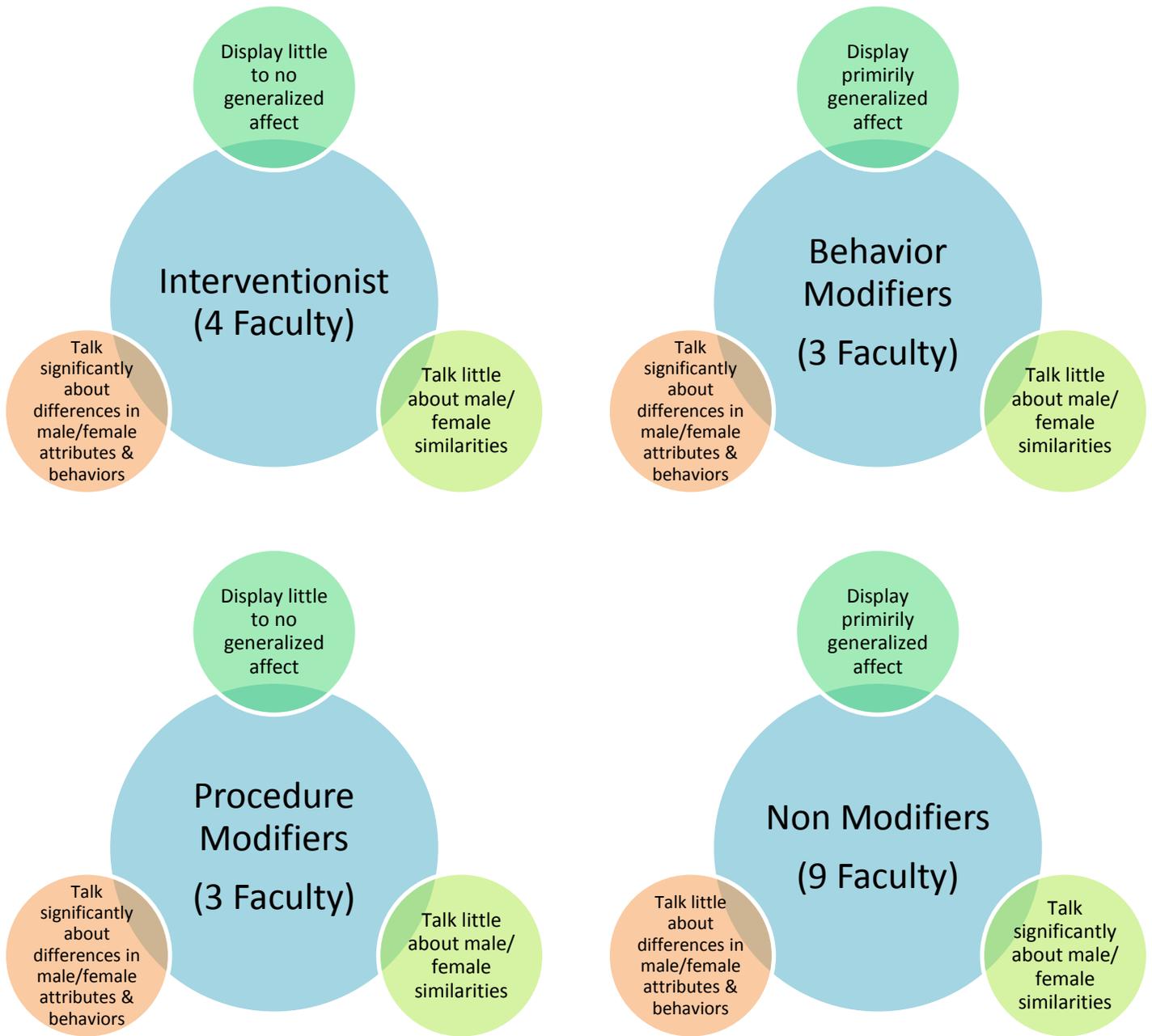
Figure 1. The preliminary framework based on faculty members gender related contingency

This preliminary framework is not fully developed and thus it is important to continue investigation into the characteristics of each of the four groups of faculty members. The next section outlines the next steps that will be taken into further developing this framework.

Future Work—*would not actually be included in a paper***
Future work with this study will further explore these emergent themes, and develop the components of our preliminary framework. In order to further explore these themes we have develop a revised codebook, with which we will recode interviews. Additionally we will attempt to divide our group of *Non Modifiers*. Some possible codes are outlined below

Code	Description	Representative Quotes
Institution Specific	any generalizations about students attributes and behaviors that pertain particularly to the instructors' current institution	But uhm and and I think I'm I think I'm particularly sensitive if it is a woman, is there a special problem, uh you know because they feel intimidated by the machines but I haven't, I haven't seen it uh I haven't seen it to be a problem. Uh it seems to be uhm I think the kind of woman student **we get here** they're eager to try this. (Tom Clark)
Percentage	Any mention of the percentage of male or female students at the institution *Note: Faculty members at the same institution often have drastically different interpretations as to the percentage of male/female students at their institution*	they do have outreach programs here they're trying to reach out to...all the grade schools and high schools b but it's got to start in grade school and it hasn't so until it does as hard as ETU tried they're not going to change the 20% female minorities' statistics. I think it will be easier for them to change the statistics on colored minorities. (Diane Troy)
Interactions with students	Any mention of how gender impacts faculty members interactions with male or females	I think I'm pretty comfortable calling equally on men and women, I don't, I don't think that I prefer men to call on. I may prefer women the other way, because I'm more comfortable and I try to tone down the you know eager beaver kind of guys, it's like oh da-da-da, oh da-da-da. You know, Ally _____ [01:02:45] do you have any thoughts on this? (Oliver Jones)
Student's Confidence	Any mention of the confidence of male or female students	...guys tend to just be more confident than maybe they even should be [Chuckles]. Women seem to be a little less confident than they should be. (Courtney Lars)
Technical Competency	Any mention of the technical competency (including preparedness and performance) of male and	there's definitely a difference in terms of technical preparation. There's definitely some differences in how they handle the hard times I think. (Kelly Nole)

	female students	
Speaking up in class	Any mention of male or female students participation in class	the men raise their hands first and fastest. I have a tendency to wait and try and call on multiple different people in the class at the same time, although women will raise their hands, but they usually raise them a little bit more slowly. (Anna Samuels)
Seeking extra help	Any mention of male or female students seeking extra help outside of class time	the girls are much more willing to come into my office, in particular the Asian girls are of the subset, you know, disproportionately represented. And, but it's not like I never have guys going to my office, but it's certainly less typical in absolute numbers and you did it per capita, the girls are much more willing to come and get help.(Donald Farns)

Citations

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Appendix A

Code	Description	Representative Quotes
Student Interest/Motivation	Any faculty mention of student motivation, interest, or involvement in learning. Student's commitment or lack of commitment to the class. Not about why students enroll in the class. Includes any mention of faculty members attempt to influence student motivation/interest	"The calc higher calc kids will choose to play on the computer and try to figure it out. It's a challenge it's a game. Why not it's here I can't go anywhere else may as well give it a go. And the other students who are just as capable mathematically… Choose to sit more...Like I honestly believe they are capable of everything here...they [can't] stay focused and that's what makes the difference in these kids." (Diane Troy)
Negative Affect (towards students)	Displays of negative emotions towards students and their work, includes generalizations	"that particular group of people, they had a series of very definite attitude problems which I have not seen in the past. That's all right. Their attitude problems are giving them zeros so and are out of the school before they give the problems to all my colleagues." (Thomas Peterson, Physics Professor)
Positive Affect (towards students)	Displays of positive emotions towards students and their work, includes generalizations	"One year there was a woman who was very good, very proactive about asking her questions… there were some guys who teased her about it...but she didn't let it interfere…she just fired away and I thought that was great, like all the power to you!" (Bethany Lee, Physics Professor)
Teaching Philosophy/Goals	What instructors want to happen as a result of their teachings especially whether they are focused on delivering content to students or developing skills. Includes statements of both their overall teaching philosophy and specific goals they want students to achieve as a result of their courses.	And I thought okay here's a chance for me to make a difference by providing fundamentals just very, very, straightforward, absolute ground level, if you can do that than we can build on it........so that's why I'm here. I figured I'm making my contribution by providing this fundamental foundations of engineering, and I think okay so that's my contribution to society" (Jeffrey Cohen, Mechanical Engineering Professor)

Faculty Motivation	Any mention of what drew faculty members to this profession/institution or what motivates them to be (good) teachers. Includes why they became a teacher and them explicitly stating what keeps them motivated to continue teaching.	"My very favorite part [of being a professor] is...thinking I'm having an impact on students. You know that's what gets me up in the morning and say, 'How am I going to excite somebody about this today." (John Pinkard, Mathematics Professor)
Perceived Ability to Make an Impact	Faculty members percieved ability to have an effect/impact on their students. Includes both (1) the short term such as faculty members putting in a significant amount of effort to transmit something to their students and seeing (or not seeing) an effect and (2) the long term such as discussing the number of students they have been able to help over their career. Additionally, this includes any time faculty members mention what students can do as a results of their course or how students are changed through their course/instruction	In teaching I enjoy extending their capabilities to do things that they couldn't do before. And and its fun when you see the light come on and somebody realizes oh I can do this or you just see their work improve. You've made a connection. You've helped somebody become a better engineer. (Tom Clark, Mechanical Engineering Professor)
Faculty Confidence	Any mention of the faculty member confidence in their teaching abilities. Displays of confidence.	"I was lecturing on something and it occurred to me...from the looks I was getting from the students...they realize that I know absolutely what I'm talking about. I don't need to go back to the book. I know cause I've done this for a living and they know that and they recognize that and there all hanging on my words..." (Jeffrey Cohen, Mechanical Engineering Professor)
Institutional Values	Any mention of administation or institutional values or practices	"ETU has emphasized projects since 1970…And important part of the project was to make something..... the CNC you know uh labs are are critical to ETU's mission.

		(Tom Clark, Mechanical Engineering Professor)
Other Faculty	Discussing the attitudes and behaviors of other faculty members. Includes any communication or relationship between themselves and another faculty member, or general disciption of a faculty member's qualities(as it relates to their teaching), i.e. "The faculty here are very qualified"	I would let people teach what they want to teach, and not force people to be grouped together and...dealing with the faculty that don't want to teach together, and fighting over who gets how many hours, and which topics gets this many hours, and which topics are covered. (Kate Beckett, Mathematics Professor, Liger) I think Anna tends to go over the quizzes in more detail than I would probably do. But I think her students, or our students, haven't done as well on some of the Physics problems, so she's needed to do that.... (Kate Beckett, Mathematics Professor, Liger)
Project/Problem Based Learning	Faculty members attitudes and behaviors towards/about PjBL and PBL. Includes both discussion of its use as a teaching method, and of its implimentation. Does not include mentioning projects as part of the structure.	I see a lot of professors who are way too theoretical, and the students complain to be about it sometimes and they say.... "oh yeah it's interesting but I don't see how to apply it."...and what happens then when I do the…we have what's called a major qualifying project it's the senior project…I get people that come into the projects and there not hands on, or not skilled in the skills that they need really to execute the project…So in other words, what happens is all these things sort of come together and it's my time that's used to fix these problems… (John Pinkard, Mathematics Professor)
Group Work	Discussion of the effectiveness of groupwork both inside and outside of the classroom. Includes faculty members attitudes and behaviors towards groupwork. Does not include mentioning groupwork as part of the structure of a class without commenting on its effectiveness.	"I don't have the impression that using conferences for group work is the most effective way to proceed...." (Thomas Peterson, Physics Professor)
Teaching-- Challenges	Any mention of the frustrations or challenges faculty members encounter while teaching students	"...in the ETU Engineering I rely on other people to do the labs. And uhm it's been challenging to try to get them to do things that I want. Uhm but uh uh in in the past uhm we've had people that were more difficult to work with... But there's still there's you know there's more things we'd like to do…"

		(Tom Clark, Mechanical Engineering Professor)
Teaching--Highlights	Any mention of what faculty members enjoy about their own teaching experiences. Includes broad generalizations and specific examples.	"The pleasurable moments are getting to see these students just take height and fly with the knowledge that they're getting…not just course work but the skills that they've gained..." (Bethany Lee, Physics Professor)
Anti-Separation	Any mention of close connections between faculty and students, especially when they are able to connect one on one. Does not include every mention of interactions with students but does include both general comments about how often they interact with students and comments on the closeness of their relationship with students.	" and they see faculty as kind of coaches, and they don't see you as some hands off, very far away distant person saying whont-whont-whont at the front of the classroom so." (Courtney Larson, Engineering Professor Tygon)
Separation	Separation between faculty and students, especially inability or difficulty to connect one on one with students. Includes lack of interaction with students due to class size or stucture	"The class I'm teaching right now I have 76 people in the class, it's suppose to be 60, two sections...... with the more students there are in a class the less time there is to actually give each one the attention that they deserve or I would like to give to them." (Jeffrey Cohen, Mechanical Engineering Professor)
Experience as Students	Any mention of the faculty members own experience as a student. Must discuss the experience and not just be a listing of where faculty members went to school	"I'm reminded of when I was a student and I was taking a heat transfer class and the professor asked a question about fluid mechanics and I raised my hand and answered it and and I gave the wrong [answer]...and the professor looked at me and said did you take fluid mechanics? And I said yes. And he said you should ask for your money back [Both laugh]." (Neal Thomas, Mechanical Engineering Professor)
Active Participation in Teaching	Any indication of faculty members active participation in teaching. Includes faculty members changing their teaching methods and	"this one young lady in the, in the lab …who I made a special effort to go over and talk to because she's…has never asked me a question And just wasn't necessary for her to ask any questions, but I went and asked her because she wasn't asking me any questions.And she really wasn't having any

	support as a response to students or after identifying an area of improvement	problem....But I check in anyway to find out which way it is. (Jeffrey Cohen, Mechanical Engineering Professor)
Passive Participation in Teaching	Any indication of faculty members passive participation in teaching. Includes faculty members noticing problems with their course and not making adjustments	Well the conference instructor, the way Bethany is doing things, does not have a great deal to do usually because...I hand out homework, I hand out the class work. I may spend 10 or 20 minutes...discussing something...I give back the previous group work and I may discuss, "Here's where people consistently went way off course and here's what you need to do to fix it," And the rest of the time I sort of sit there and uhm look decorative." (Thomas Peterson, Physics Professor)

Appendix B

Code	Definition
Gender	Any mention of gender at all including both (1) the use of pronouns when discussing specific students or faculty and (2) explicitly discussing the difference between genders or (3) talking specifically about an individual
Gender--Students	Any mention of gender as it relates to faculty members
Gender--Faculty	Any mention of gender as it relates to students
Negative Student Behaviors/Negative Affect towards students	Any mention of negative student behaviors or displays of negative emotions towards students and their work, includes generalizations
Positive Student Behaviors/Positive Affect towards students	Any mention of positive student behaviors or displays of positive emotions towards students and their work, includes generalizations

Code	Definition	Example Quotes
Pronoun Slip Up	Any use of a personal pronoun when giving a general example or a hypothetical situation.	"I like it. I mean the…I like pairs I don't like triples. Uhm pairs are good on a computer 'cause three people can't see a computer and so always one isn't you know he just lets the other two do the work." (Diane Troy,)
Assumptions	Any generalizations about male or female students NOT explicitly based in faculty's observations of their students.	"A woman who's decided to go to an engineering school even, whether she's going to be an engineer doesn't matter, but come to an institution like this has dealt with this, if there's a problem before she's dealt with it and knows how to get around in the system." (John Pinkard)
Similarities	Any discussion of the similarities between male and female students. Both unprompted and in response to questions about if men and women are different in specific ways. Includes any mention of gender's lack of impact. Also includes any mention of interacting with male and female students the same way (when in relation to the students characterisitcs and not soley the characteristics of the faculty)	"male or female at this school they all come with the same stuff. There are kids that are scared of math just because it's math even though they're real good at it." (Diane Troy, 3178)
Specific Stories	Any mention of experiences with specific students, in which the gender of the students is very clear. These stories often use gender specific pronouns throughout the retelling of the experience.	"I was cheering on Margaret the other day because …she's always sitting in the back. And and she's she's not…one of the students whose behind or anything like that, she's actually doing quite well in the class, but ... she's quiet and never seems to really quite engage, and whenever she raises her hand I'm like "Yes, you, right now" [Laughs]. " (Anna Samuels, 390)
Attributes/Behaviors	*Any general statements about the differences between male and female students attributes (such as confidence or technical competency) or behaviors (such as speaking up in class or seeking extra help)* Includes seeing trends in attitudes or behaviors.	"sometimes the confidence level thing. You do see a difference in, where guys are more likely to be oh yeah, I'm good at that, and the woman with the same level of talent or expertise or whatever, says I guess I'm okay, but I don't know." (Courtney Lars, 658)
Affect Towards Students	Any gender specific expression of feelings towards students.	"And I love the women. They are hot tickets which they have to be…" (Diane Troy, 2565)

	Includes preferring the attitudes or behaviors of one gender over another, and any expression of feelings where gender is specified.	
Gender Contingency	Any mention of treating students differently or treating students the same in relation to their gender. Includes paying attention to students or calling on them because of their gender. Includes any classroom modifications with gender in mind.	"Uhm, but ah yeah, I I think gender dynamic wise uhm the class is going very well. I'm starting to see…I have been watching out for the one signs of loosing female students, loosing interaction and such like that, and I haven't been seeing them so far until the mid-terms." (396)