



## **What's Trust Got to Do with It? Assessing a Research-Based Mentoring Program for Novice Engineers**

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# What's Trust Got to Do with It? Assessing a Research-Based Mentoring Program for Novice Engineers

## Abstract

While the importance of trust has largely been explored in large business organizations, little attention has been given to the role of trust in one-on-one mentoring relationships between engineers<sup>1</sup>. Trust has been relatively understudied in academic settings, especially in mentoring relationships between undergraduate and graduate students in research laboratory settings. By assessing ways of creating and maintaining trust in engineering relationships, we will be able to create more comprehensive guidelines on building relationships through research experiences. In order to assess the level of trust in engineering relationships, and particularly in underrepresented groups of women and minorities (URMs), our research team will explore the role of trust in an established research-based mentoring program, called Your Own Research Experience at CU (YOU'RE@CU), that pairs graduate student mentors with undergraduate mentees.

The YOU'RE@CU program takes place at the University of Colorado Boulder's College of Engineering and Applied Science and is in its third year of operation. The program goals include improving the retention rate of undergraduate women and URMs in engineering, increasing the undergraduate's interest in research, and preparing graduate student mentors for leadership roles in either industry or academia. The program is held during the spring semester where the undergraduate students complete a one-credit pass/fail seminar course in which they learn about a variety of research practices and opportunities, become familiar with the graduate school admission process, meet industry professionals, and tour college research laboratories hosted by faculty members. In addition to the seminar, undergraduate mentees are paired with a graduate mentor to complete a hypothesis or objective-based, level-appropriate project during the same spring semester. To gain further information on student attitudes, undergraduate students complete several surveys to gauge their excitement and interest in engineering prior to beginning their research. The students also complete a post-research survey about their experiences. The undergraduate students gain practical research experience and demonstrate their accomplishments in an end-of-semester poster presentation. Both the undergraduates and graduate mentors complete weekly qualitative reflective questions through an online process.

Through both the pre- and post- surveys, as well as reflective questions posed during the semester, the research team gathered information on maintaining and creating trust in these mentoring relationships. We compared and contrasted our mentor-mentee relationship to the perceived trust model created by Mayer, Davis, and Schoorman<sup>1</sup>. Our initial findings show that ability, benevolence, and integrity are all factors that create trust in engineering relationships. However, additional factors such as group collaboration and feelings of inclusiveness allow mentees to create a stronger level of trust in research-based relationships. By evaluating this mentoring program, we were able to gain more information on trust that can help us empower and inform the novice engineer and mentors in research-focused engineering relationships. The research results from this program can guide others as they seek to establish similar programs in mentoring and research programs addressing retention of underrepresented students in engineering.

## Introduction

The national enrollment of underrepresented minorities (URMs) in engineering in 2009 was 16.4%, and at the University of Colorado Boulder it was only 11.0% in 2012<sup>2,3</sup>. It is also troubling that the qualifications of women tend to be equal or slightly better than their male counterparts, yet their retention rates in engineering are only slowly growing or declining<sup>4</sup>. Mentoring is one pathway to address this imbalance, and is becoming a common tool that is used throughout universities. Mentoring programs have been known to increase retention and may give students a feeling of belonging<sup>5</sup>. However, much of the literature currently focuses on long-term mentoring relationships and there is limited literature that focuses on short-term, research-focused, undergraduate mentoring programs<sup>4,5</sup>. Since the format of mentoring relationships can be versatile, there are significant differences between mentoring programs. These differences can include: formal and informal relationships, the length of the relationship, and whether the relationship occurs in a professional setting or in higher education. The variety in the structures of mentoring programs makes it difficult to create a set of universal characteristics that can guide the creation of a successful mentoring relationship. Whether the mentoring models that were derived from long-term relationships in industry and large organizations can be applied to short-term and research-based relationships between undergraduate and graduate students is not well understood.

A factor that may have a significant influence on the quality of the mentoring relationship is the level of trust in the relationship between the mentor and the mentee. Interestingly, the role of trust at the university level, and especially within engineering, has not been established in the literature. The majority of the research findings on trust have been in the context of non-academic professional organizations<sup>1</sup>, between a supervisor and employee<sup>1</sup>, and in professional mentor and mentee relationships<sup>6,7</sup>. However, the role of trust in the higher education setting remains understudied. Mentored relationships in academia are often unbalanced due to the significant influence that the mentor may have over the mentee's grades, stipend and research funding, and the mentee's professional career and reputation. Further, engineering faculty members tend to be Caucasian and male, and therefore may lack understanding or practice to form a trustful relationship with women and URM students<sup>8-10</sup>. Trust in mentoring is interrelated with gender and is a critical factor in male-dominated professions<sup>8</sup>. Similarly, interracial dynamics in mentoring relationships have both positive and negative outcomes<sup>11</sup>, where the development of trust may depend on factors ranging from societal and cultural norms as well as socioeconomic status. Trust likely provides a necessary foundation for mentoring relationships, and especially in the engineering profession.

Our research team hypothesizes that trust is a critical factor in developing an effective engineering mentoring relationship. We intend to outline and describe characteristics necessary to create trust in these relationships to create more successful mentoring programs and increase the retention rates of URMs and women in engineering.

## Background

### *Models of Mentoring*

While there is no one single definition of mentoring that is capable of encompassing every possible type of mentoring relationship, it is helpful to focus on explanations of mentoring that

are relevant for the YOU'RE@CU program and other research-focused, academic mentoring programs. Models of mentoring can help to explain the differences that exist in relationships between mentors and mentees. Previous papers by the authors have examined mentoring models and mentoring in engineering<sup>12</sup>; therefore, a simple overview is provided in the following paragraphs.

Glaser and Strauss investigated academic mentoring relationships in higher education. Besides providing guidance, the mentor also becomes a developmental role model, taking a personal interest in the mentee and working to enhance their academic preparation<sup>13</sup>. Burlew offers another model of mentoring that considers three different stages of mentoring: 1) training; 2) education; and 3) developmental<sup>14</sup>. However, one of the most comprehensive descriptions of mentoring relationships is offered by Kram, who suggests that there are two primary functions of a mentor: in the career domain and in the psychosocial domain<sup>15</sup>. In the career domain, the mentor supports and coaches the mentee. In the psychosocial domain the mentor serves as a friend to the mentee, beyond their career responsibilities. Kram also suggests that there are four stages in a mentoring relationship: 1) Initiation, 2) Cultivation, 3) Separation, and 4) Redefinition. In the initiation stage, both the mentor and mentee are very excited for their relationship to begin and have mutual respect for each other. As the relationship progresses into the cultivation stage, the mentee is given more responsibility and opportunities to work independently. In the third stage, both partners in this relationship may experience feelings of loss or anxiety and both evaluate the importance of their relationship. The final stage consists of a relationship that is based more on friendship than on work, and both mentor and mentee have developed mutual respect for each other<sup>15</sup>. Kram's model is generally used to describe informal relationships that form naturally between people that last multiple years.

Although Kram's model is widely accepted, it does not fit the YOU'RE@CU program exactly, since it is only a semester long and is considered a formal mentoring program. The abbreviated length of our program does not enable most participants to develop past these initial stages. However, the examples of relationship development provided by our participants is relevant to many mentor-mentee relationships in short-term academic activities such as independent study, coursework, class project teams, and relationships established during short workshops. Kram's model also only considers the feelings and perceptions of the mentee and not the mentor and thus is limited in its inability to describe the interactions. A relationship cannot be evaluated solely on one partner's perception.

### *Existing Mentoring Programs*

To help increase the retention rate of students in engineering, many universities often implement formal mentoring programs to increase interest in engineering – especially directed towards women and URM students. Many of these programs were encouraged by the findings from the retention literature<sup>16</sup> that indicate how students require personal attention to create a more personable and welcoming space to counteract the sometimes “chilly” engineering environment. Basic overviews of a variety of mentoring programs found in engineering institutions are provided in Table 1. These mentoring programs have similarities to the type of mentoring program used in the YOU'RE@CU program, with the Graduates Linked with Undergraduates in Engineering (GLUE) program closest in comparison. The GLUE program, like the YOU'RE@CU program, provides graduate student-mentored projects for novice engineering students.

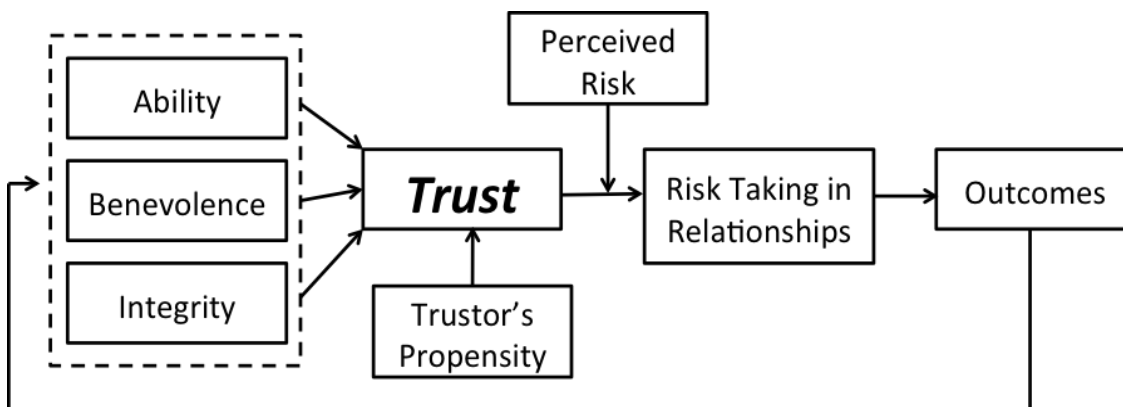
**Table 1: Mentoring Program Examples in Engineering**

<b>Program Name and University</b>	<b>Key Attributes</b>
ENGR0081 at the University of Pittsburgh	<ul style="list-style-type: none"> <li>• Zero-credit course required for all first-year engineering students</li> <li>• Pairs 10 to 15 undergraduate students with a single mentor, who chooses a non-academic theme<sup>17</sup></li> <li>• Percentage of honors, probation, transfers, and quantitative survey results show positive effect on students<sup>18</sup></li> </ul>
GUIDE at Michigan Technological University	<ul style="list-style-type: none"> <li>• Matches a freshman with a sophomore, junior, or senior, and graduate student</li> <li>• Required to attend weekly meetings with topics determined by program coordinator</li> <li>• GPA tracking and survey results shows students had a positive experience and credit GUIDE for increasing interest in engineering and science<sup>19</sup></li> </ul>
WIN at University of Arkansas	<ul style="list-style-type: none"> <li>• Matches 1<sup>st</sup> and 2<sup>nd</sup> year women with upper-class women in the same department</li> <li>• Aims to encourage students to participate in departmental activities and to become members of engineering culture</li> <li>• Improved environment and culture of engineering cited in qualitative comments from participants<sup>20</sup></li> </ul>
GLUE at University of Texas at Austin	<ul style="list-style-type: none"> <li>• Pairs undergraduates in their 2<sup>nd</sup> and 3<sup>rd</sup> years with graduate mentors who work on a research project during the spring term</li> <li>• Goal is to expose women and URM students to the research environment</li> <li>• Alumni credit the program as the reason they found successful careers in industry and academia<sup>21</sup></li> </ul>

*Perceived Trust Model*

Close examination of responses from the previous two years of the YOU'RE@CU program highlighted recurring themes of trust and commitment in the responses to reflective questions and in focus group discussions with the students. This led the research team to look at trust as a major component in engineering mentoring programs. While little mention of trust has been found pertaining to academic or research-based mentoring programs, an extensive model developed to describe trust in large organizations<sup>1</sup> relates well to aspects of the YOU'RE@CU

program's mentoring model. This model, which can be seen in Figure 1, has served as a basis for examining the development of the graduate-undergraduate relationship in our mentoring program.



**Figure 1:** Perceived Trust Model, adapted from Mayor *et al.* (1995)<sup>1</sup>, where the factors of ability, benevolence, and integrity are critical to establishing both a trustful environment and a propensity to trust by the mentor and the mentee.

This model uses three factors: *ability*, *benevolence*, and *integrity* that can influence one's ability to trust. These three factors must be applied simultaneously in this model to form a trusting relationship. If one of the factors is reduced or left out, it will serve to create a lack of trust in the relationship. The next aspect to the trust model is the propensity to trust, which is a person's inherent ability to trust others. Then through taking risks in the relationship, an outcome will evolve. Similar to a feedback loop, the cycle then begins again based on the previous outcomes wherein a different (or not) level of trust is reestablished.

One of the three components necessary to create and maintain trust in a relationship is *ability*. Ability is the group of skills, competencies, and characteristics that can influence a party in a specific domain. It is important that the definition of ability is restricted to within a specific, defined domain because the trustee maybe talented in one area and lacking ability in another. Other studies have also suggested that instead of ability, the term 'competence' can adequately describe this characteristic. Demonstrating ability or competence is extremely critical to gain the trust of the trustor<sup>1</sup>. Secondly, the level of trust may be affected by *benevolence*, or the extent to which a trustee is believed to want to do good to a trustor aside from an egocentric motive. Benevolence implies that the trustee has a specific attachment to the trustor. The final factor of *integrity*, relates to the trustor's perception that the trustee adheres to a set of principles that they find acceptable. When these three factors are applied simultaneously and effectively, trust is nurtured in a relationship. Without one or more of these factors, a lack of trust in the relationship can exist<sup>1</sup>.

This model is interesting and somewhat more inclusive than other more widely accepted mentoring models because it can apply to both partners in the relationship, the mentor and the mentee. It is a two-way model. In many accepted mentoring models, only the mentee is explicitly considered<sup>15</sup>. In the current work trust is a critical factor for evaluating both the mentor and mentee's feelings as they progress through their relationship. Since either the mentor or the

mentee can be perceived as either a trustor or trustee, the trust model enables us to evaluate the role of trust by both parties in the YOU'RE@CU mentoring relationships.

Following the evaluation of ability, benevolence and integrity, the next important factor in the relationship is the trustor's *propensity to trust*, which is a person's inherent ability to trust others. Propensity to trust is usually created through life experiences and personality<sup>1</sup>. If a person has chosen to never trust others because of their life experiences, it will not matter how much of the three primary characteristics are possessed or applied by their partner. In contrast, someone who is very trusting generally trusts others from the time when they are first introduced. A person's inherent propensity to trust is important to the level of trust in a relationship, as it guides the development of a mentoring relationship.

Overall, trust is a willingness to be vulnerable to another person, so it is reasonable to question the *amount of risk* involved with being vulnerable<sup>1</sup>. A higher degree of trust will increase the likelihood of risk-taking in relationships. Whether or not a specific risk will be taken by the trustor depends on one's propensity to trust as well as their perception of the degree of risk. Each repeated trust cycle leads to new and different level of trust<sup>1</sup>.

In the present study, the trust model is used as a guide to assess the aspects of trust in the mentor-mentee relationship in the YOU'RE@CU program. We focus primarily on the three characteristics of *ability, benevolence, and integrity*. By evaluating these three characteristics, we can examine the behaviors of the graduate mentors and the undergraduate women and URM students who are in research-based relationships that can help us to optimize future offerings of the program.

## Methodology

The YOU'RE@CU program is held during the spring semester. The undergraduate students must meet attendance, writing and poster requirements to receive a pass/fail credit for a one-hour weekly seminar course. In addition to the seminar, undergraduate mentees are paired with a graduate mentor to complete a hypothesis or objective-based, level-appropriate project during the same spring semester. While the seminar course is assessed through the post-survey, this work focuses on developing a greater understanding of the mentored research experience.

The YOU'RE@CU program is assessed using a mixed-methods approach, by using both qualitative and quantitative methods to collect and analyze results<sup>22</sup>. All participants completed a quantitative pre-experience survey via online survey software<sup>23</sup> to assess their attitudes and experience levels. In addition, throughout the semester qualitative reflective questions were given to the program participants on a regular basis during the course of the semester using secure online forms as well as during in-class focus groups<sup>24</sup>.

In the second year of implementation, the YOU'RE@CU program supported 13 mentees and 13 mentors, a number that is slightly larger than the previous year's cohort of 10 undergraduate mentees paired with nine graduate mentors. Mentors were recruited from all departments in the College of Engineering and Applied Science, with six departments participating. Mentees were recruited from 1st and 2nd year undergraduates supported by the BOLD (Broadening Opportunity through Leadership and Diversity) Center, the diversity-serving organization<sup>25</sup> in the College of Engineering and Applied Sciences at the University of Colorado Boulder. All

participants were informed that the data collected from these assessment activities would remain anonymous and used for research purposes exclusively. The option to not participate in the surveys and other assessment activities was always available to participants without any penalty to their course grade. From the 13 pairs of mentors and mentees, a mean of 11 responses were received for the reflective questions and the post-survey.

Undergraduate mentees were asked four sets of reflective questions during the semester and participated in two focus groups, while the graduate mentors answered three reflective questions. The quantitative survey items were taken from two primary sources, the Academic Pathways of People Learning Engineering Survey (APPLES) and the Assessing Women and Men in Engineering (AWE) Project, as well as additional survey items inserted at the research team's discretion<sup>26, 27</sup>.

Qualitative data were collected through open-ended questions on the application survey as well as ongoing reflective questions posed online<sup>24</sup>. The reflective questions were designed by the research team to probe the development and feelings of trust between mentor and mentee. During this second year of program implementation, similar questions were posed to both mentors and mentees to determine the differences in perception between the undergraduate mentees and graduate mentors. The set of reflective questions and their schedule of administration are found in Appendix A.

The research questions – aimed to examine the undergraduate mentee’s perceptions of trust and their attitudinal reactions to their mentored research experiences – helped to quantify each relationship’s degrees of perceived trust. The research team identified three principal research questions for the YOU'RE@CU program, as shown in Table 2.

**Table 2: Three Principal Research Questions for the YOU'RE@CU Program**

<b>Research Question</b>	<b>Assessment Method</b>
1. Were the mentees in the YOU'RE@CU program satisfied with the program overall and with their mentors?	<ul style="list-style-type: none"> <li>• Post-attitude survey</li> <li>• Mentee reflective questions</li> <li>• Mentee focus group</li> </ul>
2. How do the specific traits of ability, benevolence, and integrity influence a mentee’s attitude toward their mentor?	<ul style="list-style-type: none"> <li>• Post-attitude survey</li> <li>• Mentee reflective questions</li> <li>• Mentee focus group</li> </ul>
3. What is the importance of a collaborative work strategy and how does it affect a mentee’s level of trust for her or his mentor?	<ul style="list-style-type: none"> <li>• Pre- and post-attitude survey</li> <li>• Mentee reflective questions</li> <li>• Mentee focus group</li> </ul>

While the YOU'RE@CU program is part of a much larger project with additional research goals, in this article we address the results that are specific to trust and the three research questions presented in Table 2. These outcomes based on trust can play a strong part in creating effective mentoring programs and research-based relationships in academia and in promoting retention in engineering of women and URM students.



## Results and Discussion

Here, we summarize the major findings from qualitative and quantitative data that were gathered from the undergraduate mentees during the second year of implementing the YOU'RE@CU program within the College of Engineering and Applied Sciences at the University of Colorado Boulder.

### *Research Question Number One: Were the mentees in the YOU'RE@CU program satisfied with the program overall and with their mentors?*

A baseline set of expectations obtained prior to the research experience was used to compare the results from the post-attitude survey to assess whether the mentees in the program had an overall positive experience. For all of the quantitative questions, the students were given the opportunity to rate their satisfaction on a five point scale, from very dissatisfied to very satisfied. See Appendix A for a list of the questions administered to the mentees.

For evaluation purposes, each response was then assigned a numerical value that can be seen in Table 3 to more consistently (and numerically) evaluate the responses across the entire group of mentees. Overall, a more positive number indicates greater mentee satisfaction and a more negative response indicates greater mentee dissatisfaction.

**Table 3:** Point Value Assigned to Quantitative Questions

<b>Response to quantitative questions</b>	Very Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Very Satisfied
<b>Point Value</b>	-2	-1	0	1	2

The responses from the 11 mentees were divided into two groups. Group 1 consists of mentees who reported that they were somewhat to very satisfied (classified as 1 and 2 on the point scale) with the amount of contact they had with their mentor over the semester. Group 2 consisted of mentees who reported that they were very dissatisfied to neutral (classified as -2 to 0 on the point scale) with the amount of contact they had with their mentor over the course of the program. The results of the different questions are summarized in Table 4, and the data are presented as the mean +/- the standard deviation.

Due the limited population size, the groups were compared solely by their means, the standard deviations were not considered when comparing the groups. Group 1 was fairly satisfied with their mentor contact time, while Group 2, the less satisfied group, reported they were “somewhat satisfied” with the amount of contact with their mentor. In contrast, Group 2 (1-2) responded more positively to all three questions collectively when compared to Group 1's ( $\leq 1$ ) collective response. Overall, both groups provided responses that were more positive than neutral; this finding suggests that all mentees were satisfied to some degree with their mentor and the program overall. In addition to these questions, all of the mentees said that they would recommend this program to their friends.

**Table 4:** Mentee Responses to Questions Regarding Satisfaction with the Program and with their Mentor. The results are presented as the mean +/- standard deviation.

	<b>Question 1:</b> Your overall satisfaction with your assigned mentor?	<b>Question 2:</b> Your overall satisfaction with all aspects of the mentoring program?	<b>Question 3:</b> My participation in the mentoring program made me more confident in my ability to succeed in engineering.
<b>Group 1:</b> Satisfied to very satisfied with contact with their mentor. (n=7)	1.57+/- 0.53	1.29+/-0.95	1.57+/-0.79
<b>Group 2:</b> Neutral to very dissatisfied with contact with their mentor. (n=4)	0.75+/-1.26	1.00+/-0.00	0.50+/-0.58

Both qualitative and quantitative questions help develop a better understanding about the elements that gave the mentees a more positive experience. Specifically, in response to the open-ended question, “*What do you like best about this mentoring program?*”, four of the eleven responses included a statement about the relationships they developed with their graduate mentors. The responses from two of the students can be seen below.

Sarah (Group 1) stated:

*“Getting to have a close relationship with my mentor where now we are friends and I can go to her when I'm stressing out or need someone to talk to.”*

Ina (Group 1) stated:

*“The individual attention you get from having a one on one relationship with a mentor.”*

Other responses from the mentees addressed the usefulness of the skills they learned, how to perform research and how to work within a research group and in a laboratory setting. For instance, Veronica (Group 2) stated:

*“I like the opportunity it gave us to get acquainted with research in general, and other engineers in the college.”*

Collectively, these responses demonstrate how close some of the relationships were between the mentor and mentee and is one example of a positive benefit to the mentored student. The mentees valued their mentors and the attention they received from them during the semester. Over one third of the students reported that the most valuable part of the program was the attention they received from their graduate mentor. This finding is significant to the research hypothesis on the importance of trust in forming a mentor-mentee relationship in engineering. This finding may suggest that frequent contact and a close relationship are critical elements to a positive mentoring relationship. Despite a limited sample size, our findings indicate that greater

collaboration and one-on-one time with a mentor is a valuable part of the relationships that were formed within our program.

***Research Question Number Two: How do the specific traits of ability, benevolence, and integrity influence a mentee's attitude toward their mentor?***

In the perceived trust model, the three critical factors to forming a trusting relationship include ability, benevolence, and integrity. We analyzed the responses to reflective questions with a focus on these three factors with compelling results.

*Ability*

The mentees were asked to reflect on their perception of their mentor's *ability* to be a good mentor and perform research with the following questions: *"Does your mentor have the ability to be a good mentor? The ability to do research?"*

One of the responses that encompassed most of the undergraduate responses can be seen below in which Jessica (Group 1) stated:

*"At first, I was very unsure about whether my mentor had the ability to be a good mentor. When I first met him, he didn't seem like he had the ability to explain things wells to me. .... As the weeks went on, I asked more and more questions, and it must have hit him that I am completely clueless about electromagnetic waves, and then he began to take more time to explain things to me. At this point, I think that he is a good mentor. He is understanding of my busy schedule, and he is able to explain things well."*

Another response elaborates on the attributes of the mentor, as provided by Becky (Group 1) who stated:

*"Absolutely my mentor is fantastic. He always explains what his procedure is and his reason for doing it. Whenever he's frustrated he makes sure to let me know what it's about before knocking his head against the table. I have learned so many new skills through his mentoring and I feel that I wouldn't have noticed nearly as many minute details if he hadn't pointed them out. Even if I don't know how to do something he doesn't just do it for me, he lets me work it out a bit until I'm absolutely sure I don't know what to do next. After, he will explain how he solved it."*

Nearly all of the respondents recognized that their mentors had an ability to do research and were doing a nice job of explaining their research; some noted their mentors were learning how to explain their research better than at the beginning of the semester. The responses from the mentees, especially Jessica and Becky, identify some of the aspects that they would qualify as part of the skill set of a good mentor. Specifically they noted their mentors had the ability to explain things well. Most of these students placed a significant amount of value on this necessary skill.

In our program, the individual student's research topics were quite technical and encompassed detailed aspects that stretched the mindsets of the early engineering students. Another important factor noted by many was their mentor's ability to provide sufficient direction and to explain details of their project – despite the advanced knowledge required to fully comprehend the

foundational underpinnings of the work. Despite the level of technical complexity of these projects, our mentees eagerly gained sufficient knowledge to perform the work and interpret their results. Many of the mentees with well thought-out and level-appropriate projects appreciated that they liked being included in the research.

The mentees with ill-defined projects mentioned that their project didn't have a direction or a goal and criticized their mentor's lack of a plan they could follow. Several students recommended that future projects have more structure. Overall, while the mentees credited their mentors for being understanding and having the ability to explain their research projects, the mentees were of mixed opinions about their mentors' abilities to create a well-structured project for them to accomplish in a short time frame. Not surprisingly, we found that the most effective relationships included those with a well-defined scope and mentor who sought to educate the mentee on the fundamental knowledge underlying the research.

### *Benevolence*

The second factor that is in the trust model is *benevolence*, or having the interests of the other person in mind during the mentoring relationship. Many students noted that their mentors understood their mentee's busy schedule, suggesting that the mentors tried to accommodate their mentee's schedules. Mentees were asked in the thirteenth week of the semester: "*During the course of this semester, have you felt that your mentor/mentee has had your best interests at heart?*".

Two of the nine undergraduate students who responded had very positive responses about their mentors being mindful of their interests.

One of the positive responses was from Becky (Group 1):

*"Absolutely. ... Whenever we had group meetings he made sure to mention the work that I was doing and always gave me credit for our accomplishments even if he did the bulk of it and I only tagged along as best I could. I felt like he wanted me to succeed."*

However, two students responded with negative undertones. One of the more negatively toned responses was from Amelia (Group 2), who stated:

*"I do think he has my best interests at heart. I think also though that he is a busy grad student and doesn't have a lot of time to be able to have my best interests at heart show...I feel like I just did this whole thing by myself, even though I do think he is a really great guy."*

These divergent responses are interesting because they demonstrate the variety of experiences the mentees had that impacted their opinions about their mentors and experiences. Many students cited their positive feelings when their mentors included them in different activities. The mentees who shared the most positive responses participated in research meetings and "shadowed" their mentors. These activities made them feel that their mentors made time for them. However, the students that responded more negatively regarding benevolence thought they were hindering their mentors and wasting their mentor's time.

In one example, Ina (Group 1), stated:

*“...towards the end of the semester, I could sense that my mentor was very stressed with his research project, and so my project sort of took a back seat in terms of priorities...I wish I had chosen to work on his project with him so that I could help him with his work, and so that he would have more motivation to keep me involved.”*

Such responses demonstrate the importance of the mentors being able to make their mentees feel included. The mentees in the YOU'RE@CU program viewed benevolence as the mentors creating a feeling of comfort and wanting to include them in their research teams. Yet one might readily acknowledge that benevolence, in this sense, is not traditionally emphasized in mentored relationships in engineering. The evidence from student responses shows that a feeling of inclusiveness is an important factor in the development of benevolence that can lead to a stronger degree of trust. Since so many of the mentees appreciated opportunities to become or feel involved, as provided by their mentors, this suggests that benevolence is a key component in effective mentoring and can help students to broaden themselves through a shared research experience.

### *Integrity*

The final factor evaluated to explore the perceived trust model was *integrity*. We examine integrity through the lens of loyalty. Here, the act of being loyal to mentor suggests that their actions are worthy of adherence. A variety of responses were obtained from the question, “*Do you feel a sense of loyalty towards your mentor?*”. Of the responses from the mentees, many were positive, but three of the eleven were negative or had negative undertones.

One of the most positive responses to the reflective questions was from Becky. She stated:

*“I do feel loyal to my mentor since he has put in so much of his own time and effort into teaching me. I know he has done his best to support my personal growth and loyalty is only a fraction of what I could possibly pay him for what he's done for me. If I had to choose between a new mentor that was a master on a difficult subject and Josh, I would want to work with Josh even if he didn't know anything about the project. He's a fantastic learner and brings me along every time that he does.”*

Then in stark contrast is the response that Ina (Group 1), submitted.

*“I would have to say no. Although I have very much appreciated the time and effort my mentor has put into this project, I don't feel a particular sense of allegiance towards him and his work. I have learned a lot, but I will not be returning to do more work with him.”*

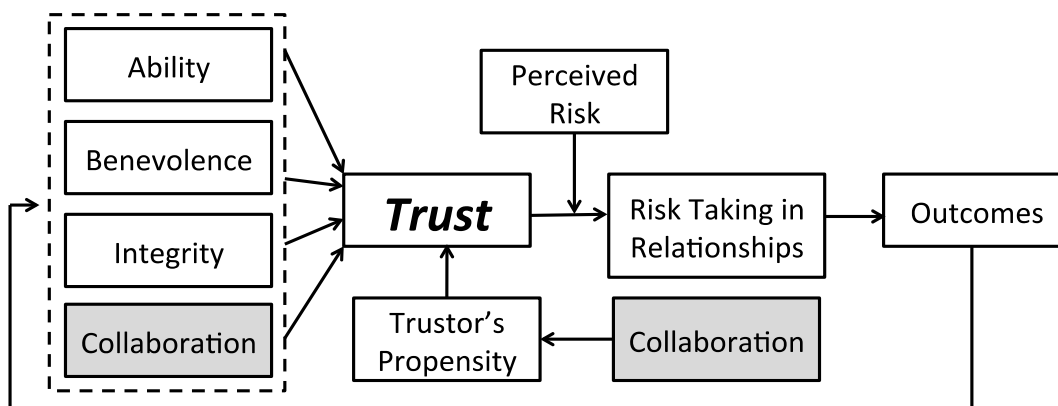
This set of responses highlighted what the students perceived as necessary for feeling loyal to their mentors and is related to integrity. Several of the students responded that their shared experiences of working closely together to solve problems on their project turned them into a team and led to them feeling close to their mentors. Another mentee mentioned that her mentor had always acted with loyalty by answering all of her questions and coming with a sense of excitement towards her project. This behavior demonstrates that this mentor acted dependably with a set of principles geared to encourage the mentee to enjoy research.

Interestingly, some mentees responded that they did not feel loyal to their mentors, but that they would still work in the lab or that they felt loyal to the lab as a whole. One student did mention that she had hopes of becoming closer to her mentor, but that when she attempted to bring up conversation it was awkward. Overall, the responses were positive and most mentees reported that they did feel a sense of loyalty towards their assigned mentors.

In considering integrity in their relationships with their mentors, the YOU'RE@CU mentees included a feeling of being a team and working together towards a common goal. Also the mentors demonstrated integrity if they were consistently excited about the project, effectively communicated, or were in contact with their mentee. Such actions to involve the mentee in decision-making implied that consistent actions targeted towards creating a team atmosphere for the mentee were important. In contrast, the students who did not feel a sufficient sense of connection with their mentor, or that the conversation was awkward or difficult, felt less connected and, consequently, felt less loyalty and trust towards their mentors when the semester was nearly finished.

**Research Question Number Three: What is the importance of a collaborative work strategy and how does it affect the mentee's level of trust for his or her mentor?**

This research question evolved as themes of collaboration and feelings of inclusiveness were expressed by the mentees. Because our program has had included a large percentage of women mentees, we hypothesized that collaborative work strategies within the research experiences should be valued. Many studies suggest that women prefer to work collaboratively in a group more than men<sup>27, 28</sup>. Also more women's responses included sentiments about feeling included or belonging when compared to the men's responses. This emphasis on collaboration supports its inclusion in a modified trust model as shown in Figure 2. This modified model may better fit the YOU'RE@CU program than the original perceived model of trust proposed. In this modified model of perceived trust, we hypothesize that collaboration is a factor that is also required for trust, and so would be grouped with ability-benevolence-integrity. Another hypothesis we propose is: while trust can exist in a non-collaborative atmosphere, collaboration can reinforce critical elements of a relationship and create an environment where the individuals have a greater propensity to trust one another. In either case, our data suggests that a role of collaboration is needed in building and possibly reinforcing the development of trust in mentored relationships in engineering research – at least within the graduate student mentored undergraduate research projects in the YOU'RE@CU program.



**Figure 2:** Perceived Trust Model where “Collaboration” is hypothesized to contribute to the three critical elements of trust (ability-benevolence-integrity) in mentoring relationships.

Many of our mentee's responses discussed how they did or did not feel included. These feelings of inclusiveness and collaboration may have not been included in the original model because it was created for business organizations whose strategies of competing in the marketplace do not necessarily involve collaboration<sup>1</sup>. The contribution of "collaboration" to the perceived trust model may better describe the characteristics necessary for mentoring women and URM students in engineering and developing the level of trust needed to conduct research relationships, especially in an academic engineering setting. Future studies will explore the role of collaboration in creating trust and/or in reinforcing one's ability to trust in a range of relationships in the engineering setting and how these factors are affected by the mentor's and mentee's rank, gender, age, engineering discipline, and other critical factors. We also hope to explore the role of trust in the engineering classroom where class size and level of technical content and difficulty will also be considered. In this manner, we hope to understand how trust is developed by both the mentor and mentee in an engineering academic environment.

## Conclusions

Previously trust has been studied in large business organizations, with little emphasis on mentoring or in academic settings<sup>1</sup>. By assessing trust in an academic research engineering environment, and especially in a small National Science Foundation-funded program that strongly encourages participation by women and URM students, we can contribute experiential knowledge on how to build effective research relationships in mentored engineering research relationships in academia. We find that the YOU'RE@CU mentoring program is ideal for examining the role of trust in engineering and academic mentor-mentee relationships. By evaluating trust between our mentees and mentors in this program, we were able to develop a novel hypothesis that collaboration plays a critical role in developing or contributing to trust and that this modified model may be applied to mentored relationships across engineering. In our program, we found evidence that substantiated the use of the three previously proposed factors for creating trust in a relationship including: *ability, benevolence, and integrity*. By focusing on these aspects, the research mentoring relationships can be strengthened. However, we hypothesize that a lack of focus on all of these three areas may underlie why academic engineering relationships are oftentimes problematic. With the ever-increasing emphasis on increasing participation of women and URM students in engineering, we see an elevated need for a comprehensive understanding of trust and its contribution to effective mentoring relationships. From our study, we found that an additional factor arose when focusing on women and URM students in engineering: *collaboration*. For the mentor-mentee relationships that we studied where collaboration was emphasized, our YOU'RE@CU students (the mentees) felt more engaged and were more trusting of their mentors. We propose that emphasizing collaboration and feelings of inclusiveness will enable the novice engineer to participate in a more trusting relationship that may lead to more confidence and overall success.

## Future Work

As the YOU'RE@CU program grows, additional focus will be placed on mentor training with a focus on developing collaborative research relationships. Ensuring that all mentors attend such mentor training prior to the start of the program should lead to more successful mentor-mentee relationships. There will also be opportunities for the mentors to have more support as they go through the program, which will include several "lunch-and-learns" throughout the semester.

These are times when the mentors can get together and learn from each other to talk about their experiences and how to overcome struggles in their research relationships. Overall, the program is trying to improve every year. By making and assessing the effects of implementing these simple changes, an increase in positive responses is anticipated.

In addition, we seek to examine the trustor's inherent propensity to trust and to determine other factors that may influence the development of trust – such as collaboration. Comparing the perspectives between the paired mentors and mentees will help to assess the overall satisfaction with the program and the role that trust plays in establishing relationships and affecting outcomes.

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## Appendix A

**Table 5:** Assessment Plan with Reflective Questions

<b>WEEK</b>	<b>DESCRIPTION</b>	<b>TYPE</b>
<b>Pre-</b>	Graduate Application	Mixed
<b>Pre-</b>	Undergraduate Application	Mixed
<b>-1</b>	Mentor Training Session	Program Event
<b>2</b>	Undergraduate Pre-Survey	Quantitative
<b>3</b>	Graduate Pre-Survey	Quantitative
<b>5</b>	Undergraduate RQ#1: What did you learn from your first (few) meeting(s) with your graduate mentor? Does the program match what you expected so far?	Qualitative
<b>6</b>	Graduate RQ#1: What concerns do you have as a graduate mentor in initiating the research relationship with your undergraduate mentee? Do you think you have areas of weakness, vulnerabilities or strengths that factor into the mentoring process?	Qualitative
<b>7</b>	Undergraduate RQ#2: What have you learned about why engineers do research? Have your views changed and if so, how?	Qualitative
<b>10</b>	Undergraduate RQ#3: Does your mentor have the ability to be a good mentor? The ability to do research? Would you like to continue this mentoring relationship in the future?	Qualitative
<b>11</b>	Graduate RQ#2: Do you as a graduate student feel a sense of loyalty to your undergraduate mentee? Do you value the relationship you have created with them? Would you want to maintain this relationship in the future? Please explain. Do you think your mentee has the ability to be a good mentee? Do they have the ability to do the required research? Please explain.	Qualitative
<b>13</b>	Poster Session	Program Event
<b>13</b>	Undergraduate RQ#4: During the course of this semester, have you felt that your mentor has had your best interests at heart?	Qualitative
<b>15</b>	Graduate RQ#3: During the course of this semester, have you felt that your mentee has had your best interests at heart?	Qualitative
<b>16</b>	Graduate Post-Survey	Qualitative
<b>16</b>	Undergraduate Post-Survey	Quantitative