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Do Goals Matter in Engineering Education? An Exploration of How Goals Influence Outcomes for *FIRST* Robotics Participants

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Abstract

It has long been recognized that engineers need a variety of skills, including technical and social, to succeed professionally. Attempts to include social skills (i.e., communication, teamwork, and leadership) in engineering education are relatively recent (i.e., within the last decade). Thus, the current study investigates whether social goals influence academic and social outcomes. Four hundred and three high-school aged *FIRST* robotics participants (262 male; 146 female; 22 not specified) completed a survey about their experiences in *FIRST*. Prior to completing the survey, participants learned that an important goal of *FIRST* was a) social networking, b) academic learning, or c) no goal. Academic and social outcomes were assessed at the beginning and end of the season, but the goal instructions were administered only at the beginning of the season. The findings show that the goals promoted can dramatically influence social and academic outcomes. The implications this has for engineering programs are discussed.

Keywords: goals, gender, robotics, social skills, social connection

Introduction

Research suggests that engineering students are entering the workforce with excellent technical skills, but with a lack of social (i.e., teamwork, leadership, and interpersonal) and communications skills (Beder, 2000). In addition, both the National Society of Professional Engineers (NSPE) and the Accreditation Board for Engineering and Technology (ABET) have recently argued that social, communication, and leadership skill sets are important factors that need to be incorporated into undergraduate engineering programs (Musselman, 2010; www.abet.org). Based on observations like these, a recent trend in engineering education is to make efforts to include the types of social skills engineers need to have on the job (e.g., teamwork, leadership, interpersonal, and communication skills) in undergraduate engineering programs. For instance, classes and curricula are starting to implement interpersonal and social interaction components through teaching activities, group work, and first year projects (Andersson, 2009; Kemppainen & Hamlin, 2009). In addition, some colleges and universities are starting to emphasize and incorporate communication and leadership skills into undergraduate engineering

courses (Bowman & Farr, 1999; Lappalainen, 2009; Vampola, Eichhorn, Thomson, Messere, & Manseur, 2010). Some schools have even created leadership institutes for their engineering students (Bayless & Robe, 2010).

Given the incorporation of different social skill components and goals into engineering curricula, engineering educational research has assessed and found positive academic outcomes that result from incorporating these components and goals into assignments, teaching style, classes, and institutions (Bayless & Robe, 2010; Prince, 2004; Shaeiwitz, 1996; Springer, Stanne, & Donovan, 1999; Terenzini, Cabrera, Colbeck, Parente, & Bjorklund, 2001; Woods, Felder, Rugarcia, & Stice, 2000). Yet, research in engineering education and applied psychology argue that learning constitutes more than academic outcomes, and that there is a need to assess outcomes in different domains, including social or interpersonal domains (Kraiger, Ford, & Salas, 1993; Smith, Johnson, & Johnson, 1981). In addition, research in social psychology suggests that another important factor to consider is the types of goals promoted, because different goals can lead to unconscious goal activation, which can, in return, influence goal pursuit (Bargh, Chen, & Burrows, 1996; Chen, Lee-Chai, & Bargh, 2001; Légal, Meyer, & Delouvée, 2007; Shah, 2003). Thus, this research expands past research by examining whether different goals (e.g., a goal to advance learning versus a goal to develop social skills and networks) influence both academic and social outcomes of engineering students.

Do Goals Matter?

The main question of interest in the current research is whether the types of goals promoted by engineering programs influence academic and social outcomes. Past research in engineering education demonstrates that specific educational outcomes can be attained from clearly stating educational goals and developing techniques (e.g., assignments, active learning activities) to achieve these goals (Bayless & Robe, 2010; Prince, 2004; Shaeiwitz, 1996; Springer et al., 1999; Terenzini et al., 2001; Woods et al., 2000). Engineering education research also shows a link between self-efficacy (or beliefs about one's capabilities and performance; Bandura, 1997) and goal attainment. More specifically, self-efficacy can mediate goal setting and attainment because students will choose challenging goals—but only when these goals seem attainable (Ponton, Edmister, Ukeiley, & Seiner, 2001). In addition, Social Cognitive Career Theory (SCCT) asserts that both social and cognitive factors predict the likelihood that individuals will become interested in and consequently pursue and succeed in different educational and career settings (Lent, Brown, & Hackett, 2000; Lent et al., 2003; Lent et al., 2005). For instance, cognitive factors, such as self-efficacy and personal goals, consciously influence educational and career paths. Likewise, more social factors, such as sex, race, or past experiences can also affect educational and career pursuits. Putting this research together, we have deduced that many factors influence goal activation, goal setting, and goal pursuit. However, the research, thus far, maintains a very conscious approach to goal activation, setting, and pursuit. In addition, this research does not examine whether different types of goals (e.g., academic versus social) influence academic and social outcomes.

While the past engineering education research presumes that individuals consciously contemplate and choose goals, social psychological research demonstrates that goals can be activated unconsciously and can subsequently influence goal pursuit (Shah, 2003). More specifically, research in unconscious goal activation demonstrates that individuals can pick up on very subtle goal cues from their social environment, and these goal cues subsequently influence behavior, performance, and beliefs. For instance, in one study participants were primed with (or exposed to) words that were related to either accuracy or inaccuracy. Those primed with accuracy words outperformed those primed with inaccuracy words on the task (Légal et al., 2007). In another study, goals were unconsciously activated in a different, albeit subtle manner. In this study, participants either sat in a professor's chair or in a guest chair. Those sitting in the professor's chair exhibited different goal-oriented behaviors than those sitting in the guest chair, suggesting that different goals were unconsciously picked up by the type of seating (Chen et al., 2001).

The goals promoted do not need to be specifically related to performance or one's environment (e.g., accuracy/inaccuracy or professor/guest); rather, individuals can pick up on goals that significant others (including faculty) have for an individual. For instance, research shows that participants primed with the name of a significant other who had a goal for that individual to succeed (e.g., their father) outperformed those participants primed with the name of a significant other who did not have the same success-oriented goal for the participant on a difficult anagram task (Shah, 2003). Thus, social psychological research shows that individuals pick up on goals and attitudes very quickly and often times unconsciously from their social environment, and these goals can significantly influence goal activation, pursuit, and behavior.

Relating this research to engineering education, the social psychological research on goal activation and pursuit suggests that the goals promoted by engineering programs may influence students' goals, behaviors, and outcomes. And, research from engineering education provides preliminary evidence of this phenomenon. For instance, this research shows that when instructors promote academic goals or when students become aware of the positive opinions others have of them in academic settings (i.e., peers, professors), then academic self-efficacy typically

increases (Hutchison, Follman, Sumpter, & Bodner, 2006; Lent, Brown & Larkin, 1986; Ponton et al., 2001). In other words, students picked up on the subtle goals and opinions in their academic environment, and these academic goals and personal opinions influenced, most likely unconsciously, academic outcomes—students' academic self-efficacy. Thus, engineering program goals are important factors to consider because these goals could have long lasting and inadvertent effects on students in terms of academic and social outcomes (e.g., increased or decreased self-efficacy).

Are Social Outcomes Important?

The second major question of the current research is whether goals influence social outcomes. Applied psychological research contends that social and affective outcomes play an important role in the learning process (Kraiger et al., 1993). Moreover, looking beyond the learning process, psychological research shows that social outcomes are an important component to development. According to Erikson's (1959) psychosocial development theory, teenagers (ages 13–19) battle between role confusion (trying to figure out what role they should play) and identity (developing a sense of who they are and what to do with their lives). Moreover, Harris (1998) argues that youth identify more with peers than parents, and consequently peers shape behaviors more than parents. Thus, engineering students may experience positive social benefits because engineering programs may provide like-minded peers and this may aid the identity-development process. Research also shows that youth who interact with others (e.g., mentors) or participate in community or educational programs show more positive developmental outcomes (e.g., self-esteem and self-efficacy) (Eccles & Gootman, 2002; Greenberg et al., 2003; Hackett, Betz, Casas, & Rocha-Singh, 1992; Harter, 1990; Larson, 2000; Small & Memmo, 2004). Thus, the social outcomes that can result from participating in interactive engineering programs early on are substantial and could have long-lasting effects on both academic and social outcomes.

The Role of Gender

Another factor that may play a significant role is the gender of the participant. While the number of females earning degrees in STEM fields has been increasing, females continue to be underrepresented in science, mathematics, and engineering and males earn more bachelor degrees in STEM subjects than females (Bell & Spencer, 2002; De Welde, Laursen, & Thiry, 2007). Research shows that females in elementary school typically achieve higher grades than males in math classes, but starting in middle school this trend reverses and males begin to outperform females in math.

One factor that may help explain the decreased performance and persistence of females in STEM fields is that of stereotype threat. Stereotype threat occurs when an individual fears confirming stereotypes of his or her group (e.g., being bad at math) and this anxiety actually hinders performance (Spencer, Steele, & Quinn, 1999; Steele, 1997). For instance, in one study, male and female college students with equivalent math backgrounds took either an easy or difficult math test. The results showed that females underperformed only on the difficult math test. Spencer et al. (1999) argue that these results show evidence of stereotype threat as the difficulty of the exam heightened the anxiety in female participants to confirm the negative gender math stereotypes.

In terms of social outcomes, it is possible that gender may also play a role–but in a different way. Females are typically described as being more nurturing and group-oriented, whereas males are typically thought of as being more reserved and independent (Smith, 2007). Moreover, females are socialized to develop more relationship-oriented attitudes and behaviors, whereas males are socialized to have more achievement-oriented attitudes and behaviors (Smith, 2007). Research also shows that as females mature (e.g., from childhood to adolescence), they develop larger social networks than males (Smith, 2007).

Present Study

The current study investigates how academic and social goals can unconsciously influence academic and social outcomes. To do this, we conducted a study on high school students who are likely to be interested in engineering (as evidenced by their after-school participation in the *FIRST* robotics program) to examine the effects of emphasizing academic versus social goals in a program that includes both types of goals. By doing so, we will be able to confirm or disconfirm the hypotheses that stem from the psychology literature in this setting.

Founded by Dean Kamen, FIRST is a not-for-profit organization that provides different programs (e.g., Lego Leagues and Robotics competitions) to draw young people's interest in engineering by providing opportunities through its programs to gain knowledge and skills in science, engineering, and technology (www.usfirst.org). Dean Kamen is an inventor and president of DEKA Research and Development Corporation—a corporation that focuses on research and developments of different inventions with a particular focus in medical devices. Kamen founded *FIRST* to spread his passion of studying technology and science to younger generations to encourage them to study science, engineering, and technology. As such, *FIRST* provides a platform for young people to work with one another, and encourages the development of communication and leadership skills. In the *FIRST* Robotics Competition (FRC), high school students, often

supervised by practicing engineers, work together on different teams to design a robot for a specific challenge. The teams are given a standard kit of parts and have 6 weeks to design and build their robot before it enters the competition.

We chose *FIRST* as our study group for several reasons. First, it is an organization that teaches young people about engineering. Second, *FIRST* very clearly articulates both academic (i.e., purpose is to learn about science, technology, engineering, and math) and social (i.e., purpose is to develop self-confidence, communication, and leadership skills) goals for its programs. Third, while research has examined the academic benefits of participating in *FIRST* (www.usfirst.org/aboutus), little research has investigated the social benefits that occur from participating in *FIRST*. Looking back at the research discussed earlier on goals, social outcomes, and gender, FIRST is also an ideal organization to investigate for these issues. In terms of social benefits, FIRST may provide participants with like-minded peers, and this has been shown to aid in the identity development process and is linked with positive developmental outcomes, such as self-esteem (Eccles & Gootman, 2002; Greenberg et al., 2003; Hackett et al., 1992; Harter, 1990; Larson, 2000; Small & Memmo, 2004). Moreover, in terms of goals and gender, the goals presented to *FIRST* participants could have very different effects based on participants' gender. For instance, an academic goal could increase male performance and hinder female performance because females may have a heightened awareness of stereotypes of women and science, whereas a social goal could increase females' satisfaction and sense of connection with *FIRST*.

To study the effects of goals on academic and social outcomes, we made participants particularly aware of one main *FIRST* goal—either a social, academic, or control goal. We then measured different social and academic outcomes. Based on the past research, we predicted that the goals primed (social, academic, control) would affect social and academic outcomes for participants. Given the substantial effect gender stereotypes can have, we predicted that females primed with the academic goal would report learning less in *FIRST* than males. However, we predicted that females primed with a social goal would feel more socially connected than males. If the results come out as we expect, then there will be broad implications for any engineering education program that aims to incorporate social goals.

Method

Participants

Participants were recruited at the beginning and end of the *FIRST* season (a 3–4 month span). At the beginning of the season, 430 participants (262 male; 146 female; 22 not specified) completed the study. Of these 430 participants, 251 (152 male; 99 female) re-took the study at the end of the season—a 58% response rate. Participants were current high school students (ages 13–18) and involved in the current *FIRST* season. The study was conducted online and included current *FIRST* high school students from over 30 states (USA), Canada, England, and Israel. All participants voluntarily participated and provided informed consent.

Design and Materials

A 2 (Length of Time: Early in Season or End of Season) x 3 (Mindset Prime: Control, Academic Focus, or Social Focus) mixed-participants design was implemented.

Mindset Prime Manipulation

Research demonstrates that working on different tasks can, at times, prime participants to think more about the related content, and it will also activate related cognitive procedures (Chartrand & Bargh, 1996). For instance, working on a mathematical task will not only increase the likelihood that individuals will think more about related mathematical concepts, but it will also activate the cognitive procedures necessary to solve mathematical problems. Based on these findings, we examined whether having different goals influenced outcomes. More specifically, we created mindset primes (Chartrand & Bargh, 1996) that reminded participants: (1) of the importance of social networking while participating in *FIRST* (Social Focus Condition); (2) of the importance of learning about science and technology while participating in *FIRST* (Academic Focus Condition); or (3) that the survey examined general experience in *FIRST* (Control Condition).

Length of Time Manipulation

To examine if length of time while participating in *FIRST* influenced participants' social outcomes, we administered the survey at the beginning and end of the *FIRST* season (a 3–4 month span). The *FIRST* season begins at the beginning of January. All teams are given the challenge of the season and a set of standardized parts. The teams then have six weeks to build their robot before they are shipped off to compete. The national competition is typically held in mid-April, concluding the *FIRST* season. Thus, we collected the data early in the 'build' season and then again after the national competition concluded.

Academic Self-Efficacy Measure

Self-efficacy is an index of how competent individuals believe they are. Academically, one learning outcome is how academically competent students feel in different learning situations. To measure academic self-efficacy, we used the Academic Self-Efficacy Scale (Muris, 2001) to

assess how well participants believed they could handle different academic situations. For instance, "How well can you get teachers to help you when you get stuck on your schoolwork?" Questions were answered on a 5-point Likert-Type Scale (1 = Not Very Well; 5 = Very Well).

Social Connectedness Measure

Social connectedness relates to the quantity and quality of the social connections individuals have with others. We used the Mediated Social Connectedness Scale (Gonzales & Gay, under review) to assess feelings of connection to others in *FIRST*. For instance, "When participating in *FIRST*, I have a sense that I am part of a larger community." Questions were answered on a 7-point Likert-type of scale (1 = Strongly Disagree; 7 = Strongly Agree).

Social Skills

We used the Teenage Inventory of Social Skills Scale (Inderbitzen & Foster, 1992) to measure the different types of social behaviors teenagers engage in that may facilitate interaction. For instance "I talk more than others when I am with a group of people." Questions were answered on a 7-point Likert-type Scale (1 = Does not describe me at all; 7 = Describes me totally).

Competition

We used the Competition Scale (Ryckman, Hammer, Kaczor, & Gold, 1996) to measure attitudes towards competition. For instance, "I enjoy competition because it gives me a chance to discover my abilities." Questions were answered on a 5-point Likert-type scale (1 = Strongly Disagree; 5 = Strongly Agree).

Other Measures

Participants indicated the amount they believed they learned by participating in *FIRST*, the time they spent with their friends from *FIRST*, and also provided demographic information (e.g., gender, age).

Procedure

Participants were recruited via email and postings on a *FIRST* blog. Participants logged onto a website and gave informed consent. Participants then saw one of three different instructions (mindset prime manipulation). One-third of the participants learned that an important goal of *FIRST* was social networking, one-third learned an important goal of *FIRST* was academic learning, and one-third learned the survey assessed experiences in *FIRST*. Participants then completed a survey assessing learning and social outcomes. Learning outcomes were assessed through self-perceptions of the amount learned while participating in *FIRST* and through academic self-efficacy. We relied on self-perception data because more objective measures were not available or practical to implement in this study. Social outcomes were assessed through the self-reported amount of time spent socializing with *FIRST* friends and the validated scales that measured social connectedness, social skills, and competition. Demographic information was also collected. Participants completed the survey at the beginning (e.g., early-mid January) and end of the season (mid-late April; approximately 3–4 months later). The mindset prime was only administered at the beginning of the season. All participants were debriefed at the end of the season.

Results

Social Outcomes

Overall, the results show that priming a social goal significantly influenced social outcomes (see Table 1 for a summary).

Amount of Socializing

To assess the amount of time participants spent socializing with their *FIRST* friends, we conducted a repeated measures analysis of variance (ANOVA) with the amount of time participants spent with *FIRST* friends at the beginning (Time 1) and end of the season (Time 2) as the within-participants factor. The instructions (academic focus, social focus, control), participant gender (male, female), and time in *FIRST* (a few months, 1 year or more) served as the between-participants factors.

There was a significant interaction between the gender of the participant and the amount of time they spent with their *FIRST* friends, $F(2, 173) = 4.37$, $p = .04$. Females at the beginning of the season reported spending more time with their FIRST friends ($M = 10.5$, $SD = 1.2$) than females at the end of the season ($M = 6.10$, $SD = 1.7$) where $t(173) = 2.00$, $p = .05$.

Table 1
Summary of Findings

Outcome	*F*	*p*
Social Outcomes		
Amount of Socializing		
Gender * Time in *FIRST*	4.37	.04*
Instructions * Time in FIRST * Time Friends	3.40	.04*
Social Connectedness		
Gender * Instructions	2.58	.08+
Social Skills		
Gender	8.17	.01*
Attitudes Towards Competition		
Gender	3.15	.08+
Gender * Instructions	6.64	.01*
Academic Outcomes		
Amount Learned		
Gender	8.62	.00*
Academic Self-Efficacy		
Gender	4.52	.04*

As seen in Figure 1, there was also a 3-way interaction between the instructions given to the participant, the amount of time he or she spent with his or her *FIRST* friends, and the participant's time in *FIRST* $F(2, 173) = 3.40$, $p = .04$. Participants who are new to FIRST with the social focus instructions reported spending more time with *FIRST* friends at the end of the season ($M = 15.3$, $SD = 2.5$) than at the beginning of the season ($M = 8.15$, $SD = 1.7$), $t(173) = 2.25$, $p = .03$. However, participants who are new to *FIRST* with the academic focus instructions reported spending more time with *FIRST* friends at the beginning of the season ($M = 12.0$, $SD = 1.7$) than at the end of the season ($M = 4.90$, $SD = 2.5$), where $t(173) = 2.25$, $p = .03$.

Overall, these findings suggest that the mindset primes have more of an effect on those who are new to *FIRST* than those who have been in *FIRST* for a longer period of time. Moreover, the participant's mindset early on in the season influences the social outcomes. More specifically, when given an academic focus, participants spend less time socializing over the course of *FIRST*. However, when given a social focus, over the course of *FIRST,* participants spend more time socializing. Thus, the type of emphasis that *FIRST* and *FIRST* mentors give about the program to participants can significantly impact how they view *FIRST*, the amount they learn, and the extent to which they social network and socialize. It is important to note that this effect occurred 3–4 months after seeing the instructions.

Social Connectednes

In addition to the amount of time participants spent socializing with their *FIRST* friends, we were also interested in how socially connected participants felt towards *FIRST* by the end of the season. To examine this, participants responses to the Social Connectedness Scale at the end of the season (Time 2) were analyzed using a three-way analysis of variance (ANOVA) with the survey instructions (Academic Focus, Social Focus, Control), participant gender (male, female), and time in *FIRST* (a few months, 1 year or more) as factors.

There was a marginally significant interaction between gender and instructions $F(2, 193) = 2.58$, $p = .08$. Males who received the control instructions ($M = 5.83$, $SD = .93$) had more positive feelings about *FIRST* than males who received the academic instructions ($M = 5.44$, $SD = .94$), $t(193) = 1.94$, $p = .053$. Males who received the social instructions ($M = 5.83$, $SD = .86$) also had more positive feelings about *FIRST* than males who received the academic instructions ($M = 5.44$, $SD = .94$), $t(193) = 2.03$, $p = .045$.

Looking at the comparison between males and females with the academic instructions, the results show that females with the academic instructions ($M = 5.90$, $SD = .93$) felt more positive about *FIRST* than males with the academic instructions ($M = 5.44$, $SD = .94$) where $t(193) = 2.37$, $p = .019$. There were no other main effects for

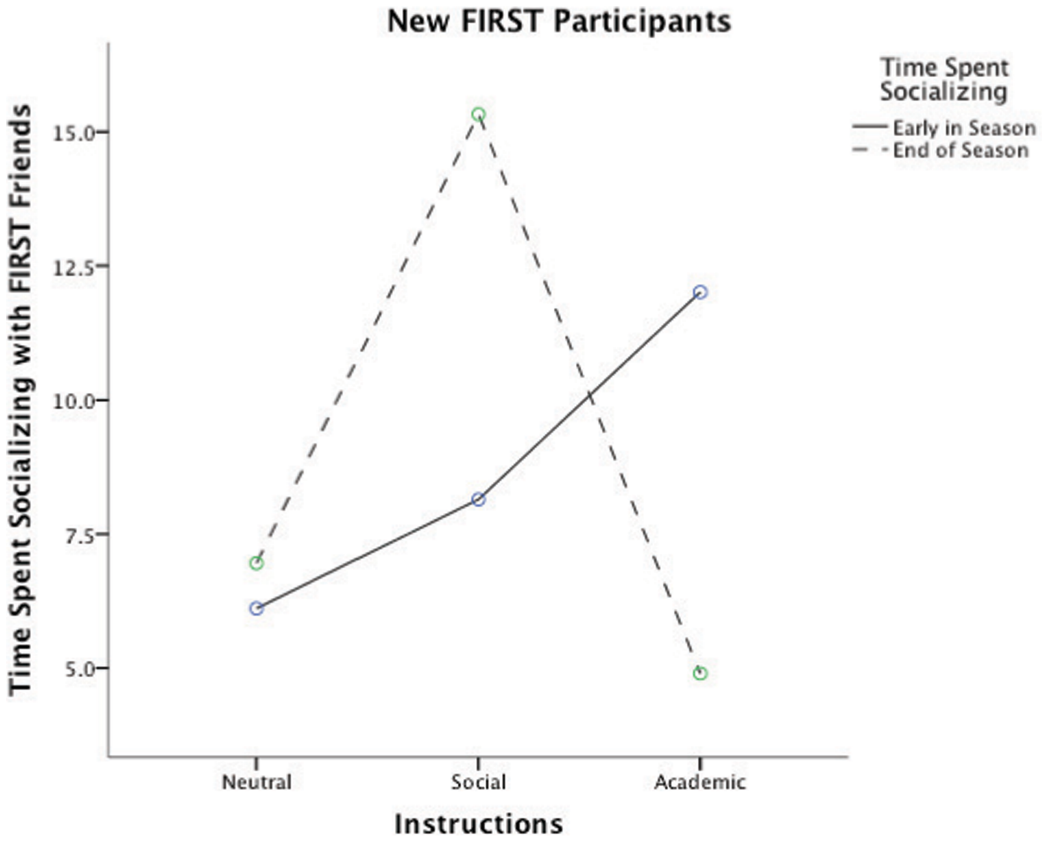

Figure 1. The effect of subtle goals on time spent with *FIRST* friends at the beginning and end of the season for new *FIRST* participants.

instructions, gender, or time in *FIRST* (*p*s > .05), nor were there any other interactions (*p*s > .05). Thus, males who were primed with the academic focus reported less favorable attitudes towards *FIRST* than their female counterparts also primed with an academic focus and their male counterparts who were primed with the social or neutral focus.

Social Skill

We were also interested in whether participants developed more adaptive social skills by the end of the *FIRST* season. Responses to the Social Behaviors Scale at the end of the season (Time 2) were analyzed using a three-way analysis of variance (ANOVA) with the survey instructions (Academic Focus, Social Focus, Control), participant gender (male, female), and time in *FIRST* (a few months, 1 year or more) as factors. There was a main effect of gender, $F(1, 189) = 8.17$, $p = .01$. Males reported having less social skills ($M = 5.30$, $SD = .65$) than females ($M = 5.56$, $SD = .62$) at the end of the *FIRST* season. There were no other main effects for instructions, gender, or time in *FIRST* (*p*s > .05), nor were there any other interactions (*p*s > .05). Thus, by the end of the FIRST season, females show evidence of more social skills than males.

Attitudes Towards Competitio

In addition, we were interested in how attitudes towards competition developed over the *FIRST* season. Attitudes towards competition at the end of the season (Time 2) were analyzed using a three-way analysis of variance (ANOVA) with the survey instructions (Academic Focus, Social Focus, Control), participant gender (male, female), and time in *FIRST* (a few months, 1 year or more) as factors.

There was a marginally significant main effect for gender, such that males ($M = 4.25$, $SD = .72$) reported being more competitive than females ($M = 4.12$, $SD = .76$), $F(1, 195) = 3.15$, $p = .078$. As seen in Figure 2, this marginal main effect was qualified by a significant interaction between gender and the instructions $F(2,195) = 6.64$, $p = .01$. Looking just within the male participants, those with the control instructions ($M = 4.40$, $SD = .68$) reported being more competitive than males who received the academic focus instructions ($M = 4.0$, $SD = .77$), $t(195) = 2.51$ $p = .01$. Males with the social focus instructions ($M = 4.36$, $SD = .63$) also reported being more competitive than males who received the academic focus instructions ($M = 4.0$, $SD = .77$), $t(195) = 2.26$, $p = .03$. Thus, males primed with the academic instructions tend to have less competitive attitudes.

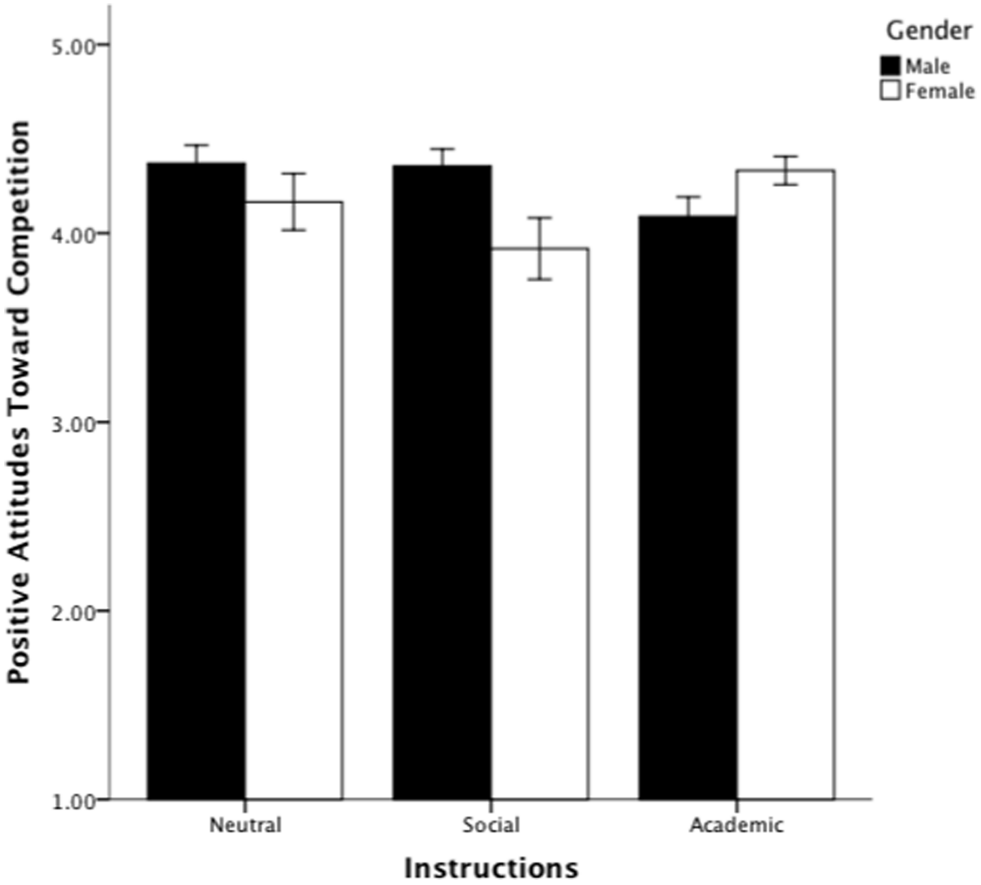

Figure 2. The effect of subtle goals and participant gender on positive attitudes towards competition.

However, this effect was opposite for the female participants. Females who received the academic focus instructions ($M = 4.31$, $SD = .46$) felt more competitive than females who received the social focus instructions ($M = 3.86$, $SD = 1.0$), $t(195) = 2.65$, $p = .01$. In addition, females with the academic instructions reported being more competitive ($M = 4.32$, $SD = .46$) than males with the academic instructions ($M = 4.00$, $SD = .77$), $t(195) = 1.87$, $p = .06$. Thus, the academic instructions increased feelings of competition for female participants.

Finally, the social instructions increased feelings towards competition for males, but not for females. Males who received the social instructions reported being more competitive ($M = 4.36$, $SD = .63$) than females who received the social instructions ($M = 3.86$, $SD = 1.0$), $t(195) = 3.01$, $p = .00$. There were no other main effects for instructions, gender, or time in *FIRST* ($ps > .05$), nor were there any other interactions ($ps > .05$). Thus, surprisingly, when males are primed with social focus instructions, they report being more competitive than their counterparts (whether other males in different priming conditions or females). Females, on the other hand, report being more competitive than their counterparts when they are primed with an academic focus.

Learning Outcomes

Amount Learned

These analyses examined responses to questions that assessed self-perceptions about the amount of learning in *FIRST*. A repeated measures ANOVA was conducted with the Learning in *FIRST* scale at the beginning (Time 1) and end of the season (Time 2) as the within-participants factor and the instructions (Academic Focus, Social Focus, Control), participant gender (male, female), and time in *FIRST* (a few months, 1 year or more) as the between-participants factors.

The results showed a significant main effect for gender, $F(1, 182) = 8.62$, $p = .00$. Males at the end of the season reported learning more in *FIRST* ($M = 6.29$, $SD = .08$) than females at the end of the season ($M = 5.69$, $SD = .10$), $t(182) = 4.63$, $p = .00$ (see Figure 3). Also males at the end of the season ($M = 6.29$, $SD = .08$) reported learning more than males at the beginning of the *FIRST* season ($M = 5.86$, $SD = .11$), $t(182) = 3.27$, $p = .00$. There were no other main effects for instructions, gender, or time in *FIRST* ($ps > .05$), nor were there any other interactions ($ps > .05$). Thus, regardless of the prime, females reported learning *less* in FIRST than males, especially at the end of the season.

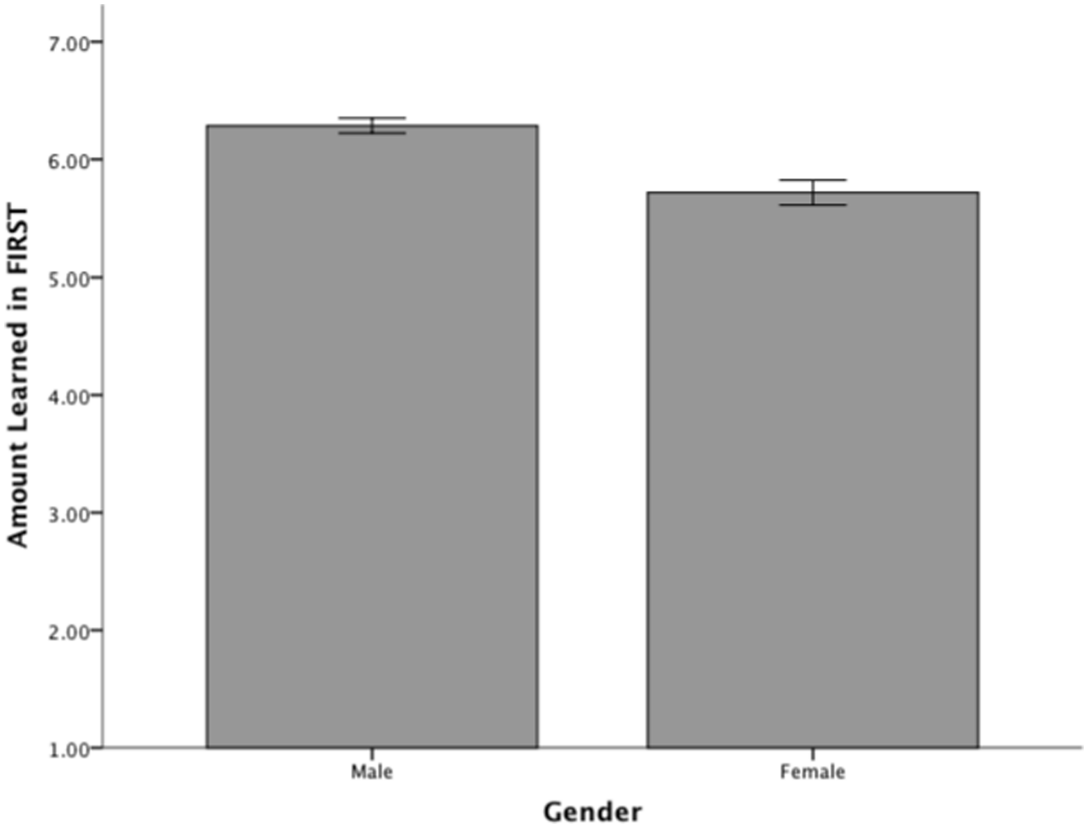

Figure 3. The effect of participant gender on self-reported learning in *FIRST*.

Academic Self-Efficacy

In addition to self-reported learning, we wanted to examine participants' academic self-efficacy at the end of the *FIRST* season. To examine if the instructions given to the participants, the participants' gender, or the amount of time spent in *FIRST* influenced the participants' self-reported academic self-efficacy at the end of the *FIRST* season (Time 2), the data were analyzed using a three-way analysis of variance (ANOVA) with the instructions (Academic Focus, Social Focus, Control), participant gender (male, female), and time in *FIRST* (a few months, 1 year or more) as factors.

The analysis showed a significant main effect for gender, such that females ($M = 4.14$, $SD = .55$) reported having higher academic self-efficacy at the end of the *FIRST* season than males ($M = 4.0$, $SD = .53$), $F(1, 194) = 4.52$, $p = .04$ (see Figure 4). There were no other main effects for instructions, gender, or time in *FIRST* ($ps > .05$), nor were there any other interactions ($ps > .05$). Thus, even though females report learning less, over time in the *FIRST* season, their academic self-efficacy becomes higher than males' academic self-efficacy. See Table 1 for a summary of the academic outcome findings.

Discussion

Overall, the results confirmed our predictions and show that the goals promoted by *FIRST,* even when subtly stated, significantly impact behavior and attitudes. More specifically, the findings from this study show that goals can be activated in a very subtle manner, and different goals (i.e., academic and social) result in very different academic and social outcomes especially for males and females. In terms of social outcomes, we found that those initially primed with social goals evidenced better social skills and felt more socially connected by the end of the *FIRST* season than those in the other conditions (especially females). However, we found that those initially primed with academic goals felt less socially connected (especially for males). Thus, social and academic goals resulted in very different social outcomes for *FIRST* participants, especially for males and females. Our results on academic outcomes show that by the end of the *FIRST* season, females feel they have learned less in *FIRST* than males. With this said, our findings also show that female participants' academic self-efficacy improves over time in *FIRST*. Thus, while their attitudes towards learning are negatively impacted, their academic self-efficacy is boosted.

Relationship to Past Research

These results map onto findings within social psychology. First, the results support the self-discrepancy theory that argues that people's views are influenced by their own thoughts and also by the beliefs of those around them (Higgins, 1989). Second, our results support and extend

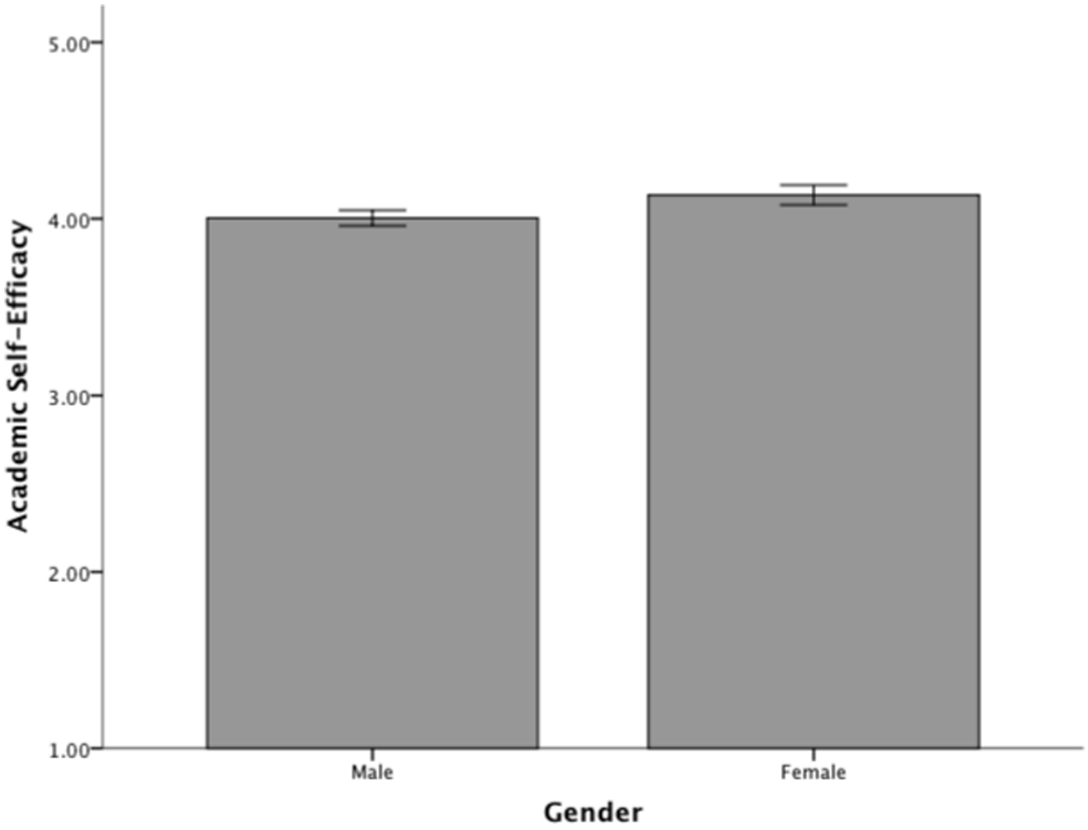

Figure 4. The effect of participant gender on academic self-efficacy.

past research on goal priming by demonstrating that people pick up on the subtle goals promoted by a group that they belong to (Shah, 2003). The findings also tie into past research in engineering education that demonstrates that clearly stating goals can influence outcomes; however, our findings extend this past research by demonstrating that goals influence academic and social outcomes (Bayless & Robe, 2010; Prince, 2004; Shaeiwitz, 1996; Spinger et al., 1999; Terenzini et al., 2001; Woods et al., 2000). Third, our results corroborate research showing that adolescent females tend to develop larger social networks than males—as our female participants socialized more and felt more socially connected than male participants, especially when given the goal to be social (Smith, 2007).

In addition, our academic outcome findings relate to past research. First, it is possible that the females' belief that they learned less is related to stereotype threat (Spencer et al., 1999; Steele, 1997). More specifically, research shows that attitudes towards one's ability can be affected by stereotype threat and self-stereotyping (Sinclair, Hardin, & Lowery, 2006). Thus, the female *FIRST* participants may be acutely aware that they are outnumbered by male participants, as there were fewer females on *FIRST* teams than males. This, in return, may inadvertently increase their awareness of the negative stereotypes regarding women and science, and consequently influence their attitudes—in this case, their attitudes about how much they learned.

Our findings also tie into past research on academic self-efficacy. Past research demonstrates that participating in community or educational programs can positively affect self-efficacy, and this was true for our female participants as their academic self-efficacy improved over their time in *FIRST* (Eccles & Gootman, 2002; Greenberg et al., 2003; Hackett et al., 1992; Harter, 1990; Larson, 2000; Small & Memmo, 2004). One limitation of the current study is that it is unclear how consciously aware participants are of their academic self-efficacy. Thus, the discrepant findings between academic self-efficacy and amount learned may be due to the conscious control individuals have over their self-reported learning, and the lack of conscious control they have over their academic self-efficacy.

Conclusions and Implications

Thus, putting all the findings together, this research demonstrates the complicated intricacies behind goals and outcomes, as there is no simple or straightforward mechanism for improving both social skills and academic outcomes for everyone. Rather, there are pros and cons of emphasizing different goals. For instance, emphasizing social goals to engineering students can have positive ramifications, such as better social skills and feeling more socially connected. However, this seems to be more effective for females than males. In addition, emphasizing social goals may come with some academic consequences (e.g., students spend more time socializing rather than learning).

On the other hand, emphasizing academic goals to engineering students can also have positive ramifications, such as greater academic self-efficacy and increased perceptions of learning. However, this seems to be more effective for males than females. In addition, emphasizing academic goals may hinder social outcomes. Before implementing a practical plan for engineering students, the different ramifications and the audience need to be considered.

While this research begins to explore the effects of different goals on outcomes, it does not examine the longer-term effects that these different goals have on students. For instance, we know that goals set early on in a robotics seasons can have lasting effects over a few months. However, we do not know whether these effects would last over the course of an entire school year or a student's entire academic career. In addition, future research should continue to examine the length of time an individual participates in a program and the effects this may have on goals and outcomes. In our study, we classified students who were rookie members or had participated for a year or more in *FIRST*. However, we did not look at people who had participated in *FIRST* for more than one year, or those who decided to switch from being a *FIRST* participant to a *FIRST* mentor. Thus, future research should consider examining the effects of the goals in the short versus long term along with the length of time an individual participates in a program.

In addition, future research should explore whether differences between explicit and implicit attitudes toward learning exist, as current research shows that these two types of attitudes do differ (Nosek, 2005; Ranganath & Nosek, 2008). For instance, future research could investigate how the type of goal promoted influences both implicit and explicit attitudes (e.g., self-esteem, self-efficacy, attitudes towards women in science, motivation). The current study only investigated explicit attitudes and it is possible that while participants may have expressed certain opinions (e.g., positive academic self-efficacy) that this may not align with their implicit attitudes (e.g., they have explicit academic self-efficacy but their implicit attitudes towards women in science decreases).

In a related manner, future research may wish to understand better how stereotypes and stereotype threat impact women and minorities in *FIRST* and engineering programs more generally. This research is important for two reasons. First, the current study examined gender differences and found substantial differences in academic and social outcomes based on gender and the goals promoted. This can have serious implications for why women choose (or do not choose) to pursue science and engineering. Second, due to the small sample size of minority participants, we were unable to investigate ethnic

differences and the combined effect of gender and ethnicity. Future research should consider how ethnicity plays a role in goals and outcomes.

In addition, research in this area could also directly explore how stereotype threat and goals impact implicit and explicit attitudes, as well as the capabilities of engineering students (or *FIRST* participants). This line of research would provide insight into whether stereotype threat and goals promoted influence attitudes towards performance in the same way as attitudes towards capabilities (or self-efficacy). This research may also help to explain why attitudes about learning decreased for women, but their academic self-efficacy increased. Moreover, this research would show how stereotype threat influences goal activation, pursuit, and outcomes.

Finally, the Social Cognitive Career Theory (SCCT) asserts that both social and cognitive factors predict the likelihood that individuals will become interested in and consequently pursue and succeed in different educational and career settings (Lent et al., 2000; Lent et al., 2003; Lent et al., 2005). However, this theory maintains a very conscious approach to goal activation, setting, and pursuit. Thus, future research on SCCT is needed in order to determine how unconscious goal activation and different types of goals (e.g., academic, social, personal) affect educational and career outcomes, as well as implicit and explicit attitudes. In addition, unconscious goal activation may be an important mediating or moderating factor in career barriers (Lent et al., 2000).

In conclusion, this research shows that the goals/messages promoted can dramatically influence outcomes. More importantly, it provides evidence that different factors, such as goals and gender, need serious consideration when planning new advances in engineering education programs because these factors can have very important effects on students and their education. In addition, this research also provides insights into recruiting and maintaining participants in engineering programs, such as *FIRST*. Thus, this research begins to understand how the goals associated with engineering-oriented youth programs may benefit participants academically and socially.

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