Rule, role and value orientations as motivations for engineering

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***Abstract**: Retention in engineering is a continuing topic of discussion amongst engineering educators. This study examines the influence of engineering as a social system on students' motivation to pursue it as a major and a career. Students' motivations are characterized as displaying a rule, role or value orientation to engineering. It was found that value orientation was the most commonly expressed and also the strongest predictor of intention to remain in engineering. Rule, role, and value orientation were significantly influenced by the presence of college graduates in the student's family, and differed significantly by major. The findings indicate the possible utility of this framework in discussions of retention and raises questions of how to encourage movement from rule orientation to value orientation.*

Context of the Study

The number of degrees awarded in engineering in the 2006-07 academic year dropped by over one percent highlighting the problem of recruitment and retention in engineering which has received significant attention in the past several years (Gibbons, 2008). The number of degrees awarded to women continued to decline, down to 18.1% from 19.3% the previous year. Cultural and social influences have been accepted as one of the drivers of this trend but not much systematic research has been done in this area.

Research Questions

Various lenses have been applied to examine this continuous downward trend but none have considered the effect of social influence (Burtner, 2005; Fortenberry, Sullivan, Jordan, & Knight, 2007; Hoit & Ohland, 1998; Seymour & Hewitt, 1997). Studies have looked at the effect of climate as a sociological variable and its effect on enrollment and persistence but none have examined the interplay between individuals and a social system/institution (Hall & Sandler, 1984; Lord et al., 2008). Based on theories of social influence we assume that the institution, which in this case we consider to be engineering, and those within it exert various pressures on engineering students. The different ways in which students respond to influences exerted by the system would greatly influence their comfort and persistence within it. This study seeks to determine whether

considering engineering students' behavior using the lens of social influence could provide a useful tool in discussions of recruitment and retention.

Theoretical Framework

The research reported here uses the model of social influence developed by Kelman in the 1950s as a framework to examine this phenomenon. This model delineates three modes of social influence viz. compliance, identification, and internalization and outlines three corresponding rule, role, and value orientations which individuals have towards the larger social system (Kelman, 2006). In the compliance stage, the means of social influence is authority and the individual is motivated to adhere to the requirements of the social structure by a system of rules and rewards. In the identification process the individual ascribes to the social structure because they find it attractive, taking on their role within it as part of their identity (Allen & Meyer, 1990; Kelman, 2006). With internalization individuals see their personal values reflected in the social system and ascribe to it as being in line with their values (Kelman, 2006).

Methodology

This study was performed with first year engineering students (N=907, N_{female}=138) at a large Midwestern university. Qualitative data were collected from students regarding their reasons for pursuing degrees in various fields of engineering, and their intention to remain in or leave engineering. These students' statements were then categorized as revealing a rule, role or value orientation as a motivation to pursue the major, or as relating to aptitude, and those which could not be categorized were discarded. Any expression of motivation to pursue the major in order to gain a tangible reward/approval or to avoid penalties/disapproval was coded as compliance, any expression of motivation to pursue the major because it involves a tangible object or subject that the student likes/loves or because a person they respect is in the profession was coded as identification, and any expression of motivation to pursue the major because the student values conceptual or abstract qualities of the major/profession/job was coded as internalization. Any expression referring to a student's aptitude for various aspects of the major or the profession was coded as aptitude. Utterances were coded multiple times where they were felt to represent more than one category. Coding was performed by three coders, one coding blind, and the agreement between any two coders was found to be substantial ($\kappa > 0.7$ *for all comparisons).*

Findings and Discussion

The analysis revealed that 5% of the utterances displayed a rule orientation, 46% a role orientation, 56% a value orientation and 11% referred to aptitude, with some statements falling into more than one category. Rule orientation was higher among females than males (6.5%; 4.7%; Figure 1). Most utterances in this category revealed students motivation for pursuing engineering as family pressure or as an avenue to achieve a career goal. For example this student expresses her motivation for pursuing electrical engineering as being a way to accelerate her career:

> *"I know a lot of the prerequisites for these jobs may not and probably won't come until I achieve the experience and high standings in my field through work, but I would like to receive the degree that is the most compatible for this area of work so I can get to the more advanced jobs sooner, and I believe that degree is one in electrical engineering."*

Role orientation was higher among males (47%; 42%). It was generally expressed as an attraction to the hands on nature of engineering or to some aspect of engineering. For example:

> *"I think electrical engineering would be a good fit for me because I love electronics. I love to take them apart and rewire them to do what I want them to do."*

Value orientation was higher than rule and role orientation suggesting that at this point in their engineering career about 56% of students have identified parallels with their own value systems. For example this student intends to use their degree to improve others' lives:

> *"…with a degree in civil engineering I could work on a number of projects that could greatly improve the living condition of my fellow man and that is something that would bring me great happiness in life."*

Value orientation was higher amongst females than males (63%; 54%). 11% of utterances were related to aptitude as the primary motivator and so could not be coded as displaying rule, role, or value orientation. Though differences in orientation were observed by gender, ANOVA analyses revealed that there was no evidence that gender had an effect on orientation $F(1,4) < 1$, *ns.*

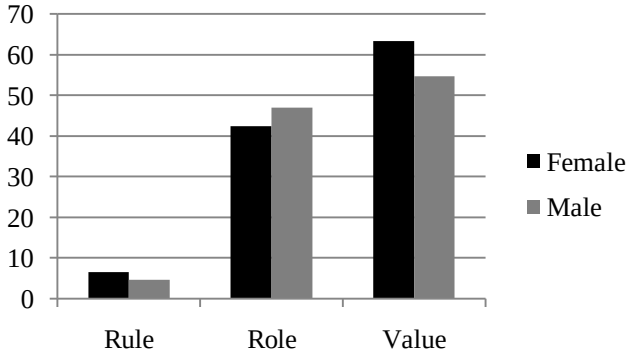

Figure 1: Percent of students by gender displaying rule, role, or value orientation

Students were asked whether they had college graduates in their family and also whether they had engineers in their family. It was believed that the presence of these individuals would serve to encourage either a rule or role orientation. The former because family pressure has been found to be a significant motivator to pursue engineering, and the latter because these family members could serve as role models making it easier for the student to see themselves as an engineer. ANOVA analyses revealed a significant effect of having a college graduate in the family $F(1,8) = 5.055$, $p<0.05$; *Figure 2* but contrary to expectations there was no evidence that having an engineer in the family had an effect on orientation $F(1,6) < 1$, *ns.*

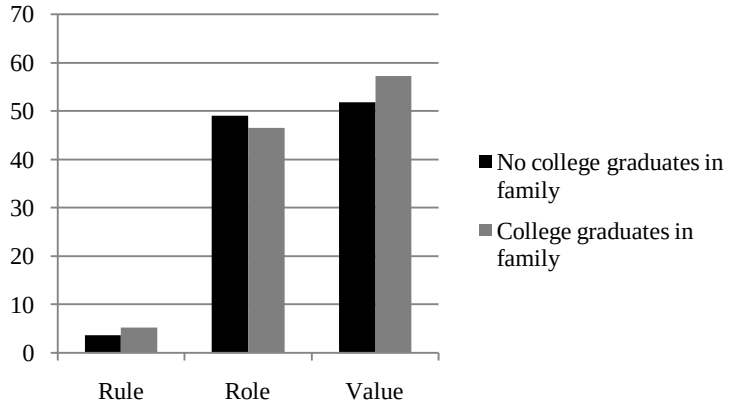

Figure 2: Percent of students with college graduates in their family displaying a rule, role or value orientation

Students were asked to indicate which of thirteen engineering majors was their first choice, and it was revealed that there was a significant effect of first choice of engineering major $F(12,26) = 2.45$, $p<0.03$; Figure 3. Chemical engineering and aeronautics and astronautics had the highest incidence of role orientation, interdisciplinary, and nuclear engineering had the highest incidence of value orientation. The high role orientation amongst chemical and aeronautical engineering students might be because both of these are popular majors within the college of engineering. This provides the students with a significant amount of exposure and a large number of role models to encourage their pursuit. The high incidence of value orientation within interdisciplinary and nuclear engineering might be because they are among the least popular majors so individuals choosing to pursue them do so because they are strongly attached to the values they see reflected within them.

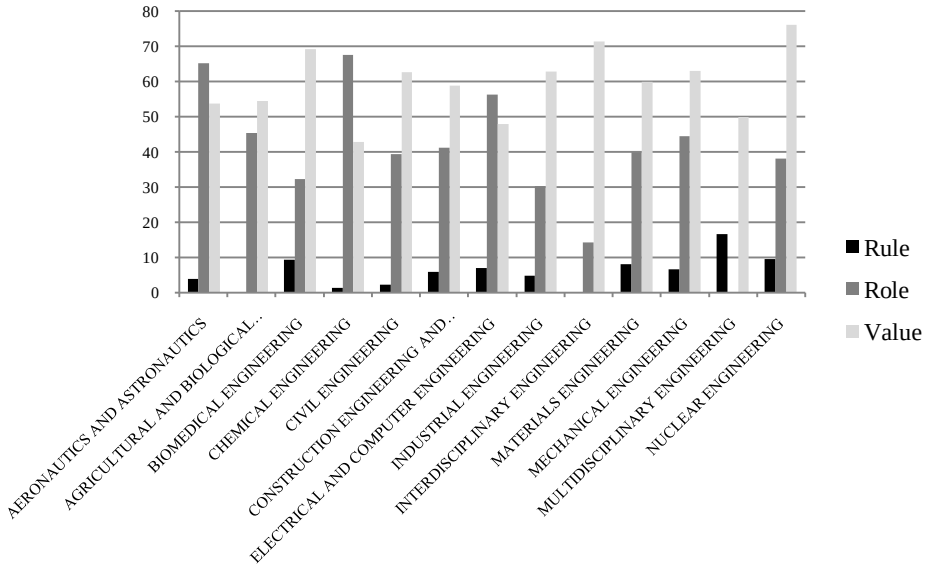

Figure 3: Percent of students by major displaying rule, role or value orientation

Regression analyses revealed that value orientation was positively correlated with intention to remain in engineering *(B=.293, p<0.05; Figure 4)* while role and rule orientation were not predictors. This is a fairly significant finding because it indicated that the strongest predictor of engineering persistence is value orientation. This is in line with the theory which indicates that value orientation is the strongest of the three.

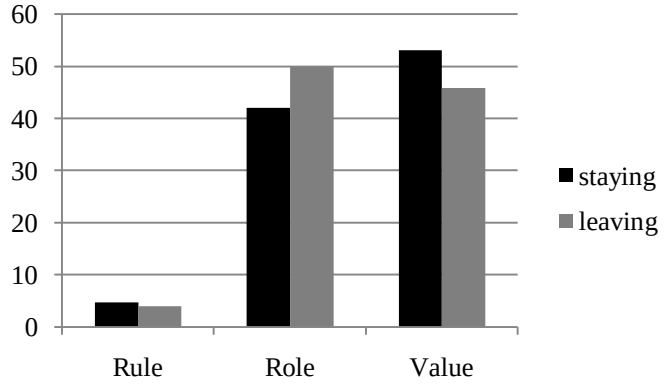

Figure 4: Percent of students by intention to persist in engineering expressing rule, role, or value orientation

Recommendations

The results reported here reveal that this model of social influence provides a useful tool for analyzing retention in engineering. As a motivational construct, value orientation would be the most desirable followed by role then rule orientation. The endurance of value systems and the personalization of identity would be more likely to persist where the removal of the pertinent authority would result in defection. It is therefore important to foster these orientations in engineering students and develop a means to help them transition from rule to role and value orientations.

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