Fitting In and Feeling Good: The Relationships among Peer Alignment, Instructor Connectedness, and Self-Efficacy in Undergraduate Satisfaction with Engineering

(Paper currently under review)

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Abstract

This study examined the relationships among peer alignment (the feeling that one is similar in important ways to one’s engineering peers), instructor connectedness (the sense that one knows and looks up to academic staff/faculty members in the department), self-efficacy for engineering class work, and engineering students’ satisfaction with the major. 135 sophomore (second-year university students) and junior (third-year students) engineering students were surveyed to measure these three variables. A multiple regression analysis showed that self-efficacy, peer alignment, and instructor connectedness predicted student satisfaction with the major, and that self-efficacy acted as a mediator between both peer alignment and instructor connectedness on the one hand, and satisfaction on the other. The authors offer suggestions for practice based on the results.

1. Introduction

According to 2009 US Department of Education data, 44% of undergraduates initially declaring an engineering major in 2004 had switched out of the major within 4 years (National Center 2009). Although this percentage compares somewhat favorably to attrition from other STEM disciplines, it presents a concern for engineering educators, and has been a prominent subject of discussion among educators and policymakers over some 20 years.

Understanding the experiences that contribute to – or detract from – undergraduates’ persistence in the engineering major is critical to improving retention rates. Factors that have been shown to predict persistence in the major for engineering undergraduates include a wide array of both academic and extra-academic factors: GPA and intrinsic motivation (French, Immekus, & Oakes 2005); self-efficacy, personal and academic support within the engineering environment, and
progress toward academic goals (Lent et al. 2007); class size, class attendance, access to the instructor, and peer collaboration (Martínez-Caro & Campuzano-Bolarín 2011); and use of academic support services (Jackson, Gardner, & Sullivan 1993); among others.

Existing research addresses both non-malleable factors, such as gender and high school grades (e.g., French, Immekus, & Oakes 2005), and malleable factors, such as confidence and interactions with instructors and peers (e.g., Litzler & Young 2012). Malleable factors are generally of more interest to educators and policymakers, since by definition they can be modified (although not necessarily easily) to help ensure more successful student outcomes. This study addresses two malleable factors which, taken together, can be conceptualized as an indicator of the students’ perceived “fit” between themselves and the program – the degree to which students feel connected to academic staff/faculty members, and the degree to which students feels well-aligned with their engineering peers – and their relationship to both self-efficacy for engineering and satisfaction with engineering coursework.

2. Background

2a. Student–Instructor Relationships

A number of studies have shown that the better college students’ relationships are with their teachers, the better are their overall college experiences and learning outcomes. Pascarella and Terenzini (1978, 1979), in one of the early studies on college instructor–student interaction, found that informal contact with instructors had a significant relationship with persistence in college among first-year students, even after controlling for a number of factors known to impact student retention. Other studies have addressed particular aspects of the undergraduate experience that are impacted by instructor contact. For instance, Kuh and Hu (2001) found that
the quality of student–instructor interaction had an effect on students’ effort in college, which in turn had an effect on their satisfaction and learning gains. Umbach and Wawrzynski (2005) likewise found that greater instructor–student interaction was related to a more engaged student body, and Anaya and Cole (2001) found that interaction with faculty members/academic staff predicted academic performance. Komarraju, Musulkin, and Bhattacharya (2010) found that students’ academic self-concept was related to their relationships with instructors, including their sense of instructors’ approachability, accessibility, and respect for students. Similarly, Eimers (2001) found that students who reported better relationships with instructors were more likely to feel they had made strides in math and science, as well as in problem-solving ability, general intellectual ability, and career development; and Graunke & Woosley (2005) found satisfaction with instructor interaction to be related to academic success. In the engineering realm, frequent instructor–student interaction has been shown to have a positive influence on the confidence of engineering students as it relates to professional and interpersonal skills (Bjorklund, Parente, and Sathianathan 2004; Chen, Lattuca, and Hamilton 2008).

Based on previous research demonstrating the positive impact of student–instructor interaction, we would expect connectedness with instructors to predict student satisfaction with engineering.

2b. Peer Relationships

Astin has written that peers are “the single most potent source of influence" (1993, p. 398) in college students’ lives, and in many respects this claim has been supported in the scholarly literature. General engagement with peers has been studied within several broad areas of research, including academic and social integration, as well as belongingness. Academic integration has been defined as “development of a strong affiliation with the college academic
environment both in the classroom and outside of class” (Nora 1993, p. 235); and social integration as “development of a strong affiliation with the college social environment both in the classroom and outside of class” (Nora 1993, p. 237). Integration into the college community generally, which encompasses engagement with peers, has been shown in numerous studies to predict student persistence in college (Berger & Milem 1999; Bers & Smith 1991; Pascarella & Terenzini 1979; Pascarella, Smart, and Ethington 1986), as well as academic achievement (Próspero & Gupta 2007; McKenzie & Schweitzer 2001). Belongingness – which has been defined as “interpersonal relatedness most dissimilar to loneliness and most closely associated with social support” (Hoffman, et al. 2002-03, p. 229) and for which peer engagement is critical – is also an important predictor of student outcomes such as self-efficacy, intention to persist, and grades (Freeman, Anderman, & Jensen 2007; Good, Rattan, & Dweck 2012; Hausmann et al. 2007; Ostrove & Long 2007; Walton & Cohen 2011). Additionally, several studies have more specifically found peer connections to predict persistence in college (Nora et al. 1996; Porter & Swing 2006).

Alignment with peers – the sense that one’s peers reflect one’s own interests and values – is narrower than and conceptually distinct from integration and belongingness. Peer alignment in college has not been studied per se, but alignment with the overall environment – what is termed *person–environment fit* – has been studied widely, mainly in vocational contexts but also in university contexts (Feldman, Smart, & Ethington 1999). This line of research has found that when the individual’s personality matches the prevailing orientation of the environment (e.g., academic department), the individual will have higher levels of satisfaction and longevity within that environment (Feldman, Smart, & Ethington 1999; Porter & Umbach 2006).
Based on the findings that both peer engagement and environmental alignment predict positive student outcomes, we would expect alignment with peers to predict satisfaction with the academic experience of engineering students.

2c. Self-efficacy

In the academic realm, self-efficacy refers to the beliefs a learner holds about his or her own ability to perform well in a particular learning area (Bandura, 1997). Previous research has shown that high levels of self-efficacy positively affect academic motivation and achievement (Pajares, 1996; Schunk, 1995), as well as persistence in problem-solving (Bouffard-Bouchard et al., 1991) and deep learning strategies that promote understanding (Liem et al., 2008). Self-efficacy has also been shown to be a precursor of interest in particular subject matter (Silvia, 2003) and a predictor of cognitive engagement (Walker, Greene, & Mansell, 2006) and of “optimal experience,” or a state of intense concentration and satisfaction (Csikszentmihalyi, 1990), in learning activities. Sources of self-efficacy are theorized to include personal mastery experiences, vicarious mastery experiences, persuasion by others, and particular emotional states (Bandura, 1997), but a wide range of particular factors have been studied as potential sources of self-efficacy. Students’ interaction with instructors appears to be a predictor of self-efficacy (Vogt, 2008), with low levels of interaction predicting lower levels of self-efficacy in students. Peers are another key source of input for academic self-efficacy beliefs, acting as models of what is possible for the individual (Schunk, 1987), and prior research has suggested that sense of belonging within the classroom, linked to interaction with both faculty and peers, is a predictor of academic self-efficacy (Freeman, Anderman, & Jensen, 2007).

3. Hypotheses
First, based on previously established connections between self-efficacy and overall academic experience, as well as between instructor connection and fit on the one hand and academic experience on the other, we expect that self-efficacy, instructor connectedness, and peer alignment will all predict satisfaction with the engineering academic experience. Further, based on the previously demonstrated relationships between self-efficacy on the one hand and peer interaction, instructor interaction, and belongingness on the other, we hypothesize that fitting in (through peer alignment and instructor connections) promotes satisfaction via self-efficacy; in other words, fitting in increases self-efficacy, which in turn increases satisfaction.

We propose the following hypotheses:

1) Self-efficacy will predict satisfaction with the major.

2) Peer alignment will predict satisfaction with the major.

3) Instructor connectedness will predict satisfaction with the major.

4) Self-efficacy will mediate the relationship between peer alignment and satisfaction.

5) Self-efficacy will mediate the relationship between instructor connectedness and satisfaction.

4. Methods

This study took place in a Fluid Mechanics course in a highly selective university in the Midwest region of the United States. This course was chosen because it is a required course for students in two engineering majors (biomedical and mechanical engineering), and thus would contain a fairly representative sample of engineering students in those majors. Participants were recruited from this course over two consecutive years, during the spring 2012 and spring 2013 quarters.
Participants took a survey consisting of 47 items, 16 of which were used in this study. Items used a 5-point Likert scale, with “strongly disagree” (1) and “strongly agree” (5) as anchors. Students took the survey in both online and paper formats. No incentives were offered for participating in the study, and the research team was not involved in teaching the classes included in the study. A total of 275 students were invited to participate, with a final sample of 135 students. Gender breakdown was 53% males and 47% females; 87% were sophomores (second-year university students) and 13% juniors (third-year students). In terms of ethnicity, 59% were White, 26% Asian American, 7% Hispanic American, 6% African American, and 2% other. All students completing the survey were included in the study.

5. Variables

Prior to establishing the final measures, we used exploratory factor analysis (a method of identifying underlying factors, or variable clusters, within of a larger set of variables; Fabrigar, 2011) to evaluate the underlying factor structure of the questionnaire items. The analysis was conducted using SPSS version 22. We used the maximum likelihood method with oblimin rotation (a particular approach to exploratory factor analysis) to determine the factor structure and the scree plot (a graphical display of the variance of each factor) to determine the optimal number of factors. This analysis yielded four factors, which can be considered the underlying dimensions that are measured by the survey questions. A 0.5 loading was used as the lower limit for inclusion in the scales. Table 1 shows the loadings (a measure of the correlation between an individual item and a factor) and Chronbach’s alpha value (a measure of internal consistency) for each of the factors. Based on the loadings, the composition of each of the underlying dimensions was extracted leading to the following variables: satisfaction with engineering, instructor connectedness, peer alignment and self-efficacy.
Satisfaction with Engineering

Because persistence itself is hard to measure, requiring longitudinal studies and careful data tracking, satisfaction with the major is often used as study outcome variables, and has been shown to predict persistence (Borden 1995; Litzler & Young 2012; Sanders & Burton, 1996; Schreiner & Nelson 2013–14). In this study, we use satisfaction with the major as an outcome variable. The Satisfaction variable, adapted from the Academic Pathways of People Learning Engineering Survey (APPLES) (Sheppard et al., 2010), is composed of six items. See Table 1 for items and factor loadings. Sample items from this scale include “I made the right decision when I decided to study engineering” and “On the whole, I think engineering classes are fun.” The calculated reliability for this variable is $\alpha=.93$.

Instructor connectedness

Instructor connectedness was defined as the extent to which students feel supported, connected to, and guided by faculty members/academic staff. This variable comprised two survey items. A sample item for this scale is “I have gotten to know one or more engineering faculty members fairly well.” See Table 1 for items and loadings. The reliability of this scale was $\alpha= 0.74$.

Peer alignment

The Peer Alignment variable was defined as the extent to which students report a sense of fit with their engineering classmates in terms of common interests and relatedness. The peer alignment scale included three items and yielded a reliability coefficient of $\alpha= 0.85$. A sample
item for this scale is “I can relate to the people around me in my classes.” It should be noted that we define peer alignment not as a general sense of comfort in classes, but rather as the sense that one shares interests, outlook, values, and so on with one’s peers. The peer alignment items were adapted from the Longitudinal Assessment of Engineering Self-Efficacy) survey developed by the Assessing Women in Engineering Project (AWE 2014). See Table 1 for items and loadings.

Self-efficacy

Self-efficacy items were adapted from the Patterns of Adaptive Learning Survey (PALS) (Midgley et al., 1996). This variable is composed of five items; sample items include “I can do even the hardest work in engineering if I try” and “Even if my engineering work is hard, I can learn it.” Alpha reliability for the self-efficacy scale is 0.93.

6. Analysis

The first part of the analysis presents the descriptive statistics of the sample for all the intervening variables. The second part will include the hypotheses tests.

Descriptive Statistics

Means and standard deviations for the four key variables are listed in Table 2.

TABLE 2 HERE

Hypothesis Tests

Because there has been previous research suggesting that social connections to instructors and peers may be especially important for women (Amelink & Meszaros 2011) – especially in the
engineering realm, where women may find it difficult to develop meaningful academic connections to faculty in a male-dominated department (Chesler & Chesler 2002) – we compared means by gender. An ANOVA (a test comparing group means) showed no significant differences by gender on any of the four key variables. As a result, we did not use gender as an additional variable in the hypothesis testing. Results are shown in Table 3.

TABLE 3 HERE

To test hypotheses 1 through 3, we ran a linear regression analysis (an approach to modeling the relationship between predictor and dependent variables; Montgomery & Peck, 2012), with Instructor Connection, Peer Alignment, and Self-Efficacy as predictors and Satisfaction as the dependent variable, using SPSS 22. The overall regression model accounted for 62% of the variance in Satisfaction scores ($R^2 = .623$, $F(3, 131)= 38.534$, $p < .0001$). As predicted, Instructor Connection significantly predicted Satisfaction scores ($b = .104$, $t(134) = 2.329$, $p < .05$), Peer Alignment significantly predicted Satisfaction scores ($b = .270$, $t(134) = 4.947$, $p < .0001$), and Self Efficacy significantly predicted Satisfaction scores ($b = .619$, $t(134) = 10.047$, $p < .0001$). These results indicate that as Instructor Connection, Peer Alignment, and Self-Efficacy increase, student’s satisfaction with engineering is also expected to increase.

To test hypotheses 4 and 5, we ran regression analyses using the PROCESS procedure (which allows for analysis of mediating and moderating variables; Hayes, 2013), model 4, in SPSS 22. This method is widely accepted as a means to better understand the conditions or factors that affect the relationship between two variables. In this analysis, we want to determine whether:
1) Self-efficacy mediates the relationship between Instructor Connection and Satisfaction (hypothesis 4),

2) Self-efficacy mediates the relationship between Peer Alignment and Satisfaction (hypothesis 5)

For hypothesis 4, we used Instructor Connection as the independent variable, Self-Efficacy as the mediator, and Satisfaction as the dependent variable. Both the direct effect (p<.05) and indirect effect (lower CI=.0115, upper CI=.2240) of Instructor Connection on Satisfaction were significant, indicating that Self-Efficacy plays a mediating role between Instructor Connection and Satisfaction. To show the significance of the indirect effect, we provide the bootstrapping (a resampling method) confidence interval. Since the interval does not include zero, we can conclude that there is a significant mediation effect of self-efficacy. This result suggests that Instructor Connection contributes to Satisfaction partially by enhancing student Self-Efficacy. That is, an increased level of connection with the instructor has a positive effect on student’s self-efficacy, which in turn contributes to increased levels of student’s satisfaction.

For hypothesis 5, we used Peer Alignment as the independent variable, Self-Efficacy as the mediator, and Satisfaction as the dependent variable. Both the direct effect (p<.001) and indirect effect (lower CI=.2340, upper CI=.4819) of Peer Alignment on Satisfaction were significant, indicating that Self-Efficacy plays a mediating role between Peer Alignment and Satisfaction. As in hypothesis 4, we evaluated the indirect effect through the bootstrapping (a resampling method) confidence interval using the same criteria as before. The result suggests that Peer Alignment contributes to Satisfaction partially by increasing student Self-Efficacy. In other words, an
increased sense of connection with student peers can have a positive effect on student’s self-efficacy, which in turn contributes to increased levels of student’s satisfaction.

7. Discussion

This study tested whether two malleable factors which together can be conceived of as “fit” in the engineering program — connection to instructors and alignment with peers — significantly contribute to student satisfaction with engineering, and what the relationship of those variables is to self-efficacy. The study found that sense of connection to instructors and alignment with peers, as well as self-efficacy, predicted students’ levels of satisfaction with the engineering major; and that self-efficacy mediated the relationships between peer alignment and satisfaction and between instructor connectedness and satisfaction. It appears, then, that both students’ sense of connection to instructors and their sense of fitting in to the classroom peer environment contribute to self-efficacy, which contributes to satisfaction with engineering school.

Our findings highlight the importance of social influences for engineering students. The results contribute to the body of previous research on student connectedness in STEM fields, showing for instance that students in STEM fields are often dissatisfied with the support they receive from instructors (Haag et al. 2009), and that students who leave engineering tend to feel isolated and lack positive, meaningful contact with both instructors and peers (Baillie 2000; Litzler & Young 2012).

Engineering instructors may not view their role in engaging students as centrally as students themselves do (Heller et al. 2010). For students, academic staff/faculty members are a critical component in their overall experience in engineering school. Gillespie (2002) describes the
“connected” student–teacher relationship as one in which “personal equality coexists with an inequality of knowledge and skills” and one which supports “coparticipation in the learning process” and exists “in sharp contrast with the fearfulness and anxiety that often [characterizes] … nonconnected student-teacher relationships.”

The finding that feeling in sync with one’s peers is important for engineering student satisfaction corresponds with previous research demonstrating the important role of peers in general student satisfaction and persistence in college (Astin 1984; Pascarella & Terenzini 1991). Whether students feel well aligned with their engineering peers, in terms of interests, values, and so on, is conceptually distinct from peer engagement, but presumably if one feels engaged with others, one also feels at least some degree of alignment. And indeed, the alignment between the individual student and his or her environment has been linked to satisfaction and achievement in college (Smart, Feldman, & Ethington 2000). A feeling of congruence with peers might also help reduce the competitiveness which can discourage engineering student persistence (Amelink & Meszaros 2011).

That these two variables – peer alignment and instructor connectedness – were found to contribute to satisfaction via self-efficacy suggests that increasing opportunities to engage meaningfully with peers and with instructors is increasing students’ feelings that they belong in engineering and can do the sort of work that engineers do.

8. Suggestions for Practice

Both individual instructors and departments or schools can influence the degree to which students interact meaningfully with instructors. Following is a set of suggestions for encouraging greater and more meaningful instructor–student interaction:
- Instructors should be aware of the important role of feedback in student learning and student motivation (Bjorklund et al., 2004; Gibbs, 2006). Feedback will be more meaningful when students are encouraged to engage with it in some way, for instance by redoing assignments based on feedback provided. Peer feedback can be used as a way to help both the feedback-receiver and the feedback-giver learn more deeply, and offers the added benefit of relieving some of the responsibility for providing feedback from the instructor. When peer feedback is used, students should receive training and guidelines on how to give and receive it most effectively.

- Instructors can interact with students during class, even in large lectures. Active-learning opportunities for students to grapple with conceptual information and to think through and solve problems in class offer far more benefit from the classroom experience than lecture alone (de Graaf et al., 2005; Smith et al., 2005). Peer discussion can be used in large and small classes to enable students to work out ideas and benefit from exposure to others’ approaches, and offers the added benefit of drawing away attention from the individual, reducing the intimidation many students feel speaking in class.

- Instructors can actively encourage students to visit their offices to discuss course material or questions students may have. Many students are intimidated by the idea of facing an instructor one-on-one with questions about a course, so that often the only students who visit instructor offices are those who are already fairly confident with the material (Karabenick, 2003; Karabenick & Knapp, 1988). Apart from announcing more frequently in class that they are glad to meet with students who have questions, instructors can offer to have students visit their offices in pairs or groups, which takes the spotlight off of the individual and can help reduce anxiety; can offer periodic alternative office hours in more
comfortable environments, such as a local café or dining hall; and can attend any existing student group study sessions to provide informal guidance on homework and exam review.

- Instructors can mentor undergraduate research projects, not just as supervisors, but as true mentors, helping to bring students into the scholarly community. True mentoring involves helping students explore their interests, allowing them to work independently with a guiding hand, and providing constructive feedback and encouragement throughout the process (Johnson, 2007). Engaging undergraduates in research or other projects with instructors also makes an impact on undergraduate engagement and persistence (Hunter, Lauren, & Seymour 2007).

Other ideas for increased interaction include instructors playing a role in residential colleges, or sharing a meal periodically with students; conversations that go beyond the class material to research, careers, and personal/professional development; and simply demonstrating respect for students and being approachable. Previous research (e.g., [citation omitted]) has shown that students who feel respected by and comfortable approaching instructors do better in their courses than students who feel otherwise. Instructors may be unaware that their behaviors send the opposite message (see Cotton & Wilson 2006), particularly for underrepresented students (Allan & Madden 2006; Salter & Persaud 2003; Solórzano, Ceja, & Yosso, 2000).

While alignment with peers is difficult to influence directly, there are steps instructors and administrators can take to help students feel more in sync with their classmates. It has long been known that peers exert an important influence on college student outcomes (Astin 1984; Pascarella & Terenzini 1991), and peer-to-peer interaction in academic settings – for instance,
peer tutoring or peer assessment – has been shown repeatedly to bear cognitive and social benefits for undergraduates (Topping 2005), especially for underrepresented ([citation omitted]) and first-generation college students (Pascarella et al. 2004). Giving undergraduates opportunities to interact meaningfully with one another in the classroom might also provide opportunities for them to learn more about one another and discover affinities. Indeed, enhancing the sense of peer alignment should not be seen as discouraging students from relating with different others. On the contrary, experiencing meaningful interactions with a wide range of peers – including those with different ethnic or cultural backgrounds, different socioeconomic backgrounds, and so on – provides a number of academic and psychosocial benefits (Chang, 1999; Denson & Chang, 2009; Milem & Hakuta, 2000). Out-of-class study groups – for instance, the supplemental instruction or peer workshop models (Drane, Micari, & Light, 2014; Hensen & Shelley 2003) – can provide less-structured academic engagement that may be even more conducive than the classroom to developing personal relationships.

Engineering education has undergone significant change in recent decades (Crawley at al. 2007; Felder et al. 2000), with emphasis on career readiness, curriculum, and teaching and assessment methods. Instructor rapport with students, and students’ own sense of alignment with their peers, have received less attention. Helping students feel they “fit in” to their engineering environments, by creating opportunities for students to engage meaningfully with instructors and to get to know their fellow engineering students, can be a critical step in promoting student satisfaction, which in turn should promote persistence in the engineering major.

9. Limitations of the study
Although the sample in this study was restricted to two sections of a single engineering course, the nature of the course as a core requirement for two majors, mechanical and biomedical engineering, makes it a fairly representative sample of engineering students those majors. The results may not be generalizable to all engineering disciplines but can provide good insight about the influence of academic fit on student academic experience.

10. References


