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The Role of Teaching Self-Efficacy in Electrical and Computer Engineering Faculty Teaching Satisfaction

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Electrical and Computer Engineering (ECE) faculty at academic institutions are charged with preparing the next generation of scientists and creators to participate in an increasingly competitive job market. As such, engineering faculty represent important capital for universities in their quest to maximize student effectiveness and their impact on the American economy. ECE faculty are expected to fulfill their undergraduate and graduate teaching duties while also generating grant funding, producing publications, and serving in numerous mentorship roles [1], [2]. Moreover, the number of students in the classroom has increased while departmental funding has decreased, resulting in fewer resources and smaller increases in compensation for faculty. Taken together, these conditions are likely to impact the teaching satisfaction of ECE faculty. Although teaching satisfaction of ECE faculty specifically has not been studied, other research has shown that faculty well-being, which includes teaching satisfaction, has been linked to faculty retention and turnover intentions [3] as well as faculty performance of job responsibilities [4]. Moreover, a qualitative study in which engineering faculty across four departments identified areas of concern found themes related to teaching demands and support, stemming in part from the reported increase of average class sizes [2]. Taken together, prior research points to the importance of developing a better understanding of how ECE faculty satisfaction with teaching can be supported better at a departmental level.

The purpose of this study was to examine two predictors of teaching satisfaction in one ECE department to achieve a better understanding of ways in which teaching satisfaction could be enhanced. This study was embedded within a large multidisciplinary effort to revolutionize engineering departments by enhancing structures, policies, and practices in engineering education. Funded by a National Science Foundation (NSF) grant (Reinventing the Instructional and Departmental Enterprise; RIDE) aimed at transforming this ECE department specifically, the present study is nested within the goal of creating substantial and lasting change to one ECE department at a large upper-Midwestern research university.

Teaching Support

Support from all levels of the university for faculty teaching is critical to ensure high-quality teaching. At the highest level, university teaching support subsumes respondents' perceptions of available resources that aid faculty members' ability to fulfill their teaching responsibilities. Department support has been conceptualized as faculty perceptions of the extent to which their department values and supports the quality and quantity of their teaching efforts through feedback and departmental policy [5]. Finally, teaching support from colleagues has been operationalized as faculty perceptions of peer assistance in the fulfillment of their teaching duties.

Only one published study [6] has explicitly focused on teaching support. Using a Taiwanese faculty sample, this investigation showed it was positively related to teaching efficacy but did not examine teaching satisfaction. Three other studies have included components of teaching support in related variables shown to be positively related to teaching satisfaction [7], [8], [9]. In a sample of tenure track faculty representing a variety of fields, department feedback and support were shown to relate positively to teaching satisfaction [9]. Among a nationwide

sample of term (non-tenure-track) faculty, a group primarily tasked with teaching undergraduate students, sufficiency of university resources for teaching was positively related with teaching satisfaction [7]. Finally, in another sample of term faculty, departmental support, which included support for teaching, was positively related to teaching satisfaction [8]. These prior studies are helpful but do not directly link teaching support specifically to teaching satisfaction. Moreover, our particular focus is on an engineering department. One theme that has emerged from focus groups across four engineering departments concerned the lack of support faculty felt when asked to teach large classes and the stress and strain placed upon them [2]. Because such faculty are imperative for preparing future engineers to participate in a viable workforce, it is necessary to examine the impact of university teaching support in such a sample.

The dearth of results regarding teaching support as a predictor of faculty teaching satisfaction, especially among engineering faculty, indicates further investigation of this relationship is necessary. Therefore, the present study aimed to explore the relationship between the teaching support these engineering faculty experience and how that support relates to their teaching satisfaction.

Chair Support

Besides teaching support at the university, department, and colleague level, support from the department chair in all aspects of the faculty responsibilities has been viewed as important to faculty members' teaching satisfaction. Chair support has been conceptualized as faculty perceptions of recognition, decision-making fairness and expediency, and satisfaction with the communication and priorities of their respective department chair. Perceived support from the department chair has been identified as a strong predictor of teaching satisfaction in national samples of term faculty [7] and tenure track faculty [9]. Additionally, support from the department chair was observed to predict overall faculty job satisfaction in a sample of term faculty [7] as well as tenured medical school faculty [10]. In this study, chair support is focused on communication with faculty and her/his interpersonal skills. Again, no studies were located that examined the role of support from the department chair in influencing faculty perceptions of teaching satisfaction among engineering faculty.

Self-Determination Theory (SDT)

In addition to establishing the utility of teaching support and chair support in predicting teaching satisfaction among ECE faculty, the current study sought to ground these relationships using the framework of SDT [11], [12]. SDT is a well-established theory of motivation which posits that environmental factors (in this case, teaching and chair support) influence the extent to which individuals experience positive outcomes of motivation, well-being, and satisfaction in a variety of domains (in this case, faculty teaching satisfaction). According to a sub-theory of SDT called basic psychological needs theory (BPNT), one's experience of satisfaction at work is contingent upon the satisfaction of basic psychological needs, one of which is particularly relevant to the present study. SDT and BPNT identify that one's need for perceived competence, or the need to feel efficacious in managing one's work environment, is an important factor in explaining satisfaction at work. Given that the present context pertains to faculty experiences in teaching specifically, the authors were interested in faculty perceptions that they are competent/efficacious in teaching. Therefore, teaching self-efficacy was chosen as an indicator

of perceived competence in this domain. Prior research in various domains has similarly treated measures of self-efficacy as synonymous with perceived competence [13], [14].

Two additional sub-theories of SDT, cognitive evaluation theory (CET) and organismic integration theory (OIT), posit that the basic psychological need for perceived competence plays a unique role in predicting outcome variables like teaching satisfaction [11]. According to SDT, basic psychological needs (e.g., teaching self-efficacy) act as mediators between environmental supports (e.g., teaching support and chair support) and outcome variables (teaching satisfaction). Applied to the present context, teaching self-efficacy would be posited to serve as a significant predictor of teaching satisfaction above and beyond teaching support and chair support. In this way, SDT provides a useful framework for conceptualizing relationships between variables of interest to the present study.

Teaching Self-efficacy

Teaching self-efficacy is defined as "a judgement about capabilities to influence students' engagement and learning" [15]. Due to the self-evaluation component of the construct along with its clear relevance for the professional academic environment, teaching self-efficacy represents a contextually grounded representation of perceived competence. Prior work has found teaching self-efficacy to be positively associated with important student outcomes such as academic achievement, intrinsic motivation, and learning self-efficacy [16]. Further, and perhaps most relevant to the current discussion, teaching self-efficacy has been found to be positively related to teaching support in a Taiwanese sample [6].

Hypotheses

The current study sought to address two primary research questions. First, do teaching support (from the university, the department, and colleagues) and chair support significantly predict teaching satisfaction? Second, does teaching self-efficacy make a significant contribution to predicting teaching satisfaction above and beyond the predictive power of teaching support and chair support? Based on the existing literature, we hypothesized that teaching support and chair support would significantly and positively predict teaching satisfaction. Further, we hypothesized, in alignment with SDT, that teaching self-efficacy would significantly predict additional variance in teaching satisfaction beyond the variance accounted for by teaching support and chair support.

Method

Participants. In line with the goals of the NSF grant outlined above, the population was the ECE department faculty at a single large Midwestern university. A total of 77 electrical, computer, and software engineering faculty were invited to complete the survey via email. Of these, 46 responded to the survey yielding a 60% response rate. Three participants were omitted due to extensive missing data resulting in a final sample size of 43. The present sample was comprised of 38 (88%) males and 5 (12%) females. The proportion of women to men in the sample was not significantly different than the proportion of women to men in the College of Engineering on this particular campus; it was also not significantly different than the proportion of women to men in ECE departments across the country (N = 4,425) [17]. While no questions

directly assessed participants' years of teaching experience, 17 (40%) were full professors with tenure, 14 (33%) were associate professors with tenure, 7 (16%) were assistant professors, 2 (5%) were associate professors without tenure, 1 (2%) was a senior lecturer, 1 (2%) identified as a lecturer, and 1 (2%) was an adjunct assistant professor. This distribution by rank is very similar to the larger department. Further, 20 (47%) identified as Asian/Pacific Islander, 19 (44%) were Caucasian/White, 3 (7%) were Black/African American, and 1 participant (2%) chose not to respond. This ethnic distribution parallels the larger department; the sample and the department compared to the Engineering College has a higher percentage of faculty identifying as Asian/Pacific Islander and a lower percentage of faculty identifying as White/Caucasian. These numbers are comparable to those found in engineering departments more broadly, with 28% of all engineering faculty identifying as Asian, 4% as Hispanic, and 2% as African American [17]. The mean age was 47.43 (*SD* = 10.2) and respondents had worked at this institution for an average of 11.9 years (*SD* = 9.8).

Measures

Teaching Support. Teaching support was operationalized using the mean score of the Faculty Perceived Teaching Support (FPTS) questionnaire [6], [5]. The scale consists of three subscales including teaching resources (university support; 4 items), administrative support (department support; 5 items), and peer support (colleague support; 5 items). The overall questionnaire includes 14 items on a five-point Likert range in which higher scores indicate more support for teaching from the university, department, and colleagues. Based on strong correlations across the three subscales ranging from .54 to .67, and to reduce multicollinearity, the authors decided to combine the three subscales into an overall mean score. For descriptive purposes, the subscale content will be described.

For the teaching resources subscale, the content began with the item stem, "The university provides" followed by facilities and resources for teaching, technology and software resources for teaching, facilities, and resources to help improve student learning, and tutoring or coaching resources for student learning. The content of the administrative support subscale items included: department cares about faculty teaching effectiveness, department has comprehensive mechanism that rewards quality teaching, administrators require high teaching quality from faculty, administrators involve faculty ideas in making teaching reward/policies that affect them, and administrators are concerned whether the teaching load is manageable. The content of the peer support subscale items begins with the item stem, "Colleagues," followed by: provide consulting service for teaching, provide teaching demonstration opportunities for me to observe, encourage, and support me if I experiment with my teaching, help me when I have a hard time in teaching, and share teaching experiences with me.

The value of Cronbach's alpha of the FPTS in the current sample was .93, which is similar to the Cronbach's alpha of .92 reported by Te-Shang and colleagues [6]. The three subscale Cronbach alpha values in this sample ranged from .88 to .94 [6]. Predictive validity estimates showed university teaching support was significantly predictive of teaching self-efficacy after the variance due to colleague support and type of university (public versus private) was accounted for [6]. Convergent validity estimates show teaching support is significantly related to teaching self-efficacy [6]. Construct validity was also demonstrated by showing that public institutions received significantly more teaching support than private institutions, as expected [6].

*Chair support***.** Chair support was operationalized using the Work Climate Questionnaire [18] and changing the word "manager" to chair. It consisted of fifteen five-point Likert items including one reverse-coded item, with 1 = strongly disagree and 5 = strongly agree. The content of the items included: chair provides choices and options, feel understood by chair, open with chair at work, chair conveyed confidence in my ability, chair accepts me, chair understood my goals, encourages questions, trusts chair, answers questions, listens, handles people's emotions very well, chair cares about me, tries to understand how I see things, and don't feel good about the way chair talks to me (reverse-coded). The value of Cronbach's alpha in the current sample was .96. Collie, Shapka, Perry, and Martin [19] reported a Cronbach's alpha value of .96 in a sample of teachers referring to principals in their schools. Principal support correlated significantly with perceived competence and job satisfaction [19].

Teaching self-efficacy. Teaching self-efficacy was operationalized by the Teaching Self-Efficacy Questionnaire [6], [20]. It included twenty-eight five-point Likert items in which higher scores indicate greater self-efficacy. The item content relates to course design (e.g., I believe I can select appropriate teaching material), instructional strategy (I have confidence in inspiring and maintaining students' learning motivation), technology (I believe I can utilize technology to enhance my teaching), usage (I believe I can nurture a pleasant learning environment), class management (I believe I can nurture a pleasant learning environment), interpersonal relation (I believe I can listen to my students in order to understand their thoughts), and learning assessment (I believe I can utilize a variety of assessment methods to evaluate students' learning results). The current sample's value of Cronbach's alpha was .92. In their study, Chang and colleagues reported a Cronbach's alpha level of .95 and found teaching self-efficacy was significantly related to university teaching support and colleague support [6]. Moreover, more experienced compared to less experienced faculty reported higher levels of teaching self-efficacy [6].

Teaching satisfaction. Teaching satisfaction was operationalized by the teaching/service satisfaction scale reported in prior studies examining well-being among faculty [7]-[9]. These items were part of a large cadre of items from the Collaborative on Academic Careers in Higher Education (COACHE) faculty job satisfaction survey [21]. The scale consists of six five-point Likert items in which higher scores indicate more satisfaction. The content of the items included number of students, number of courses, level of courses, number of students in classes on average, the quality of the students, number of students you advise/mentor, and number of committees. Values of Cronbach alpha reported for this scale in previous work have ranged from .72 to .75 [7]-[9]. The current sample's value of Cronbach's alpha was .77. Among both tenure track and non-tenure track faculty, the teaching/service satisfaction scale correlated moderately with global satisfaction and was strongly related to the COACHE benchmark Nature of Work – Teaching [7], [9]. Moreover, it was moderately correlated with upper level administrative support, chair support, and institutional support [7].

Procedure

Near the end of the semester, the survey was disseminated via the online platform Qualtrics. Participants completed the informed consent, responded to demographic items, and responded to each questionnaire before being debriefed and thanked for their participation. The survey was sent out three times, each one week apart. Participants were allowed to complete the survey only once. The participation rate was 60%. No incentive was offered to participants.

Results

Missing data. Table 1 presents the Pearson correlations, means, and standard deviations for the variables of interest. Missing data for the variables in the dataset ranged from 5% to 9%. Multiple imputation from SAS (V. 9.4) using the MIANALYZE procedure was used to conduct multiple imputation to replace missing data. Multiple imputation is considered the gold standard in dealing with missing data [22].

Sequential regression models were estimated in SAS (V. 9.4) to answer the two research questions: (1) does each form of teaching support and chair support significantly predict teaching satisfaction and (2) does teaching self-efficacy make a significant contribution to predicting teaching satisfaction beyond the predictive power of teaching support and chair support?

As part of the MIANALYZE procedure in SAS, 20 multiple imputations were performed whereby the analyses were rerun 20 separate times. A sequential regression analysis was conducted in which the criterion variable was faculty teaching satisfaction.

The aggregate of those analyses is presented in Table 2. The unstandardized coefficient pooled parameter estimate and standard error parameter for both steps can be seen in Table 2. In step one, teaching support and chair support were entered into the regression equation. In step 2, teaching self-efficacy was entered into the regression equation such that the equation consisted of teaching support, chair support, and teaching self-efficacy. Step 1 of each analysis provided an answer to question (1) above while step 2 provided an answer to question (2).

Step one of the analysis indicated that teaching support significantly and positively predicted teaching satisfaction ($b = .42$, $t = 3.80$, $p < .001$), while chair support was not a significant predictor of teaching satisfaction ($b = .11$, $t = .93$, $p > .05$). Combined, the two predictors accounted for 51.5% of the variance in teaching satisfaction, which is considered a large effect size. The hypothesis was partially supported.

When adding teaching self-efficacy to the equation in step 2, teaching self-efficacy significantly and positively predicted teaching satisfaction above and beyond the contribution of the first two predictors ($b = .46$, $t = 2.51$, $p = .017$). It accounted for an additional 7.8%% of variance in teaching satisfaction, which is considered a small effect. The second hypothesis was supported.

Discussion

As expected, teaching support significantly predicted teaching satisfaction in the current sample. These results are consistent with previous research showing that teaching support correlated with teaching efficacy [6]. Moreover, these findings extend the linkages of related environmental supports like department feedback and support to teaching satisfaction [7], [8], [9] to include teaching support specifically as a predictor of teaching satisfaction. The results of this study show that teaching support from the university, department, and colleagues relates to faculty feeling more satisfied with their teaching. This may have spinoff benefits including retention and

reduced turnover [23]. The current study extends these findings to a sample comprised entirely of ECE faculty, emphasizing the utility of these environmental supports in improving the engineering faculty experience.

Further, the second hypothesis was confirmed in that teaching self-efficacy accounted for variance in teaching satisfaction beyond that predicted by teaching support and chair support. Consistent with SDT [11] [12] [24], one of the basic psychological needs, perceived competence in teaching, contributed to the variance in teaching satisfaction, which was an index of well-being, above and beyond the environmental supports. Further, these results are consistent with previous findings that have established SDT as a sound conceptual frame for understanding the relationship between faculty work environment and faculty satisfaction [7]-[9]. Combined with previous studies, the current results lend credence to the utility of SDT in understanding and constructing a faculty environment that maximizes faculty satisfaction, a construct associated with a variety of desirable student outcomes [16].

Chair support was not a significant predictor of teaching satisfaction in this sample. This finding is inconsistent with related literature showing a link to chair support and teaching satisfaction [7], [9]. This inconsistent result may be attributed to insufficient statistical power to detect chair support, or teaching support simply may have been more salient.

Limitations

First, the current data were collected in a cross-sectional manner, which prevents the calculation of change scores and consequently prohibits establishing causal relationships among teaching support, chair support, teaching self-efficacy, and teaching satisfaction. Additionally, these results pertain to engineering departments in which women are underrepresented. As mentioned earlier, this sample was similar to the gender representation across the College of Engineering, The characteristics of the sample are considered to be representative of the broader population of ECE faculty [17].

Another possible limitation of the present study pertains to sample size, which prevented the authors from examining the components of teaching support (e.g., department, colleagues) simultaneously. However, these results are novel in that environmental supports specific to teaching have been examined only rarely in relation to teaching satisfaction. In the broader literature, support specific to teaching has not been the focus; rather the focus has been on other important supports like promotion and tenure support and research support [9]. The sample consisted of a single ECE department, and it is unclear whether the proposed SDT framework would be supported in other contexts. Pertaining to this concern, the authors point to a robust and diverse body of literature supporting the application of SDT to novel work environments [7], [8], [9]. However, the authors also note that the aim of the present study was to sample a targeted population, to gain insight into what supports satisfaction in that particular environment and to assess whether SDT fits with the findings. Although the findings may be generalizable, such was not a core purpose of the study.

Implications and Future Directions

As academic funding structures continue to change and consequently force university administrators to prioritize, it becomes increasingly necessary to examine the variables that contribute to faculty teaching performance. The current analyses revealed the usefulness of teaching supports (university teaching support, departmental support, colleague support, and chair support) in predicting teaching satisfaction in a sample of ECE faculty. University administrators overseeing ECE departments may use the current findings to establish policies aimed at enhancing these support indices for the purposing of maximizing faculty satisfaction and consequently improving student outcomes. The current study also used a well-established conceptual model of well-being to highlight the utility of the basic psychological need of perceived competence (teaching self-efficacy) as important to heightening ECE faculty teaching satisfaction. University administrators could use these findings to institute evaluation and communication practices to improve faculty understanding of their competencies while simultaneously working to improve faculty teaching competence using the supports outlined above. Specifically, through conversation administrators could ascertain faculty teaching self-efficacy in their faculty evaluation procedures as an indirect indicator of faculty well-being. Such a multi-faceted approach would likely serve to bolster existing teaching resources and could improve student learning results. Future investigations could examine the discussed relationships in other engineering faculty groups to ensure the current findings are generalizable. Additional work may also utilize a larger sample and more advanced statistical methods such as structural equation modeling to better elucidate the proposed relationship. Further, future investigations with larger samples may conduct more sophisticated regression analyses to examine for interaction (e.g., moderation, mediation, suppression) effects between teaching self-efficacy and chair support. Moreover, teaching experience, which was not assessed in this study, could be considered in future studies as a potential exogenous variable. Nonetheless, the current investigation provided support for the utility of SDT in understanding the relationships between faculty environmental supports and teaching satisfaction among ECE faculty.

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Table 1.
Summary of Means, Standard Deviations, and Correlations for All Variables under Examination, N = 43

	1	2	3	4
1. Teaching Support	-	.58	.36	.70
2. Chair Support		-	.36	.53
3. Teaching Self-efficacy			-	.56
4. Teaching Satisfaction				-
M	3.35	3.94	4.33	3.60
SD	0.94	0.91	0.51	0.77

Note. Correlations above .34 are significant at $p = .05$-level. Correlations above .41 are significant at the p-level of .01.

Table 2.

Multiple Imputation SAS Hierarchical Multiple Regression Parameter Estimates of b, Standard Error, upper and lower 95% Confidence Intervals, R^2, Change in R^2, F value for the Change in R^2, and p-values of Teaching Support, Chair Support, and Teaching Self-Efficacy on Faculty Teaching Satisfaction

Predictor	*b*	Standard Error	*95% CI*	R^2	Change in R^2	*F* value for Change in R^2	*p*
Step 1							
Teaching Support (Supt)	.42***	.11	19., .64				
Chair Support	.11	.12	-.13, .35				
				.515	.515	20.80	< .001
Step 2							
Teaching Support (Supt)	.42**	.11	.19, .64				
Chair Support	.11	.12	-.13, .35				
Teaching Self-efficacy	.46*	.18	.07, .83				
				.593	.078	7.52	.009

Note. Values in bold indicate a significant change in the percentage of variance accounted for in the criterion variable. $N = 43$. CI = Confidence Interval. These values are based on the unstandardized path coefficients. 95% confidence interval does not include zero and therefore is significant at $p < .05$, $*p < .05$, $**p < .01$, $***p < .001$.