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Gender-Based Differences in Engineering Faculty Members' Views and Use of Student-Centered Learning Strategies

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ABSTRACT

Research indicates differences exist between male and female students' preferences for pedagogical practices, such as collaborative learning. Less is known, however, about how male and female instructors view and utilize classroom strategies. To aid in exploring this new area, the Value, Expectancy, and Cost of Testing Educational Reforms Survey (VECTERS) was completed by engineering faculty members to assess dispositions towards, and use of, three student-centered learning strategies: formative feedback to adjust instruction, real-world applications, and student-to-student discussions. While there were no gender-based differences regarding reported frequency of using student-centered strategies, there were significant attitude differences – for instance, female faculty members were significantly more confident in the value and expectancy of success for real-world applications and formative feedback. There were, however, no gender-based differences in perception of costs of implementing student-centered strategies

KEYWORDS

student-centered learning strategies; faculty practices; gender; engineering education; STEM education; VECTERS

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INTRODUCTION

The traditional lecture format, which is also referred to as content- or instructor-oriented pedagogy, is the primary teaching method in undergraduate engineering classrooms (Felder & Brent, 2005; 2016). Student-centered instruction, or active learning, involves activities during the class that directly engage students and encourage their participation. There has been a growing emphasis on employing student-centered teaching strategies in the classroom, as evidence indicates these provide a more effective and engaging way for students to learn course materials (Freeman et. al, 2014). While some researchers have examined the differences in teaching strategies between male and female faculty members (e.g. Hart & Cress, 2008; Myers, 2008; Schuster & Finkelstein, 2006; Winslow, 2010), there is still much to be learned.

Research demonstrates that there are gender-based differences in learning preferences between male and female students, with female students preferring more active learning in the classroom (see Patterson, Campbell, Busch-Vishniac, & Guillaume, 2009). If faculty members are more inclined to use teacher-centered strategies over student-centered practices, this may create learning environments that benefit certain students over others. Of particular interest is whether male and female engineering instructors approach teaching differently, specifically regarding their use of student-centered or content-oriented instruction.

The purpose of this study was to determine the gender-based differences of faculty members' use of, and dispositions towards, student-centered pedagogical strategies. This study was set in the context of higher-education universities and colleges in the United States, with a focus on all engineering disciplines. Despite this study being set in the United States, the ideas explored have important ramifications for international engineering education, and can even be extended beyond engineering to other STEM disciplines.

The study was framed by two research questions:

1. What are the gender-based differences among faculty members in their frequency of utilizing student-centered strategies in engineering education?

2. What are the gender-based differences among faculty members in their dispositions towards utilizing student-centered strategies in engineering education?

LITERATURE REVIEW

Student-Centered Teaching Strategies in Engineering Education

Many empirical studies have been conducted to better understand the effectiveness of student-centered instruction in higher education. These studies have demonstrated that active-learning pedagogical techniques promote greater learning and understanding compared to traditional content-oriented strategies (Felder & Brent, 1996; Jungst, Likclider, & Wiersema, 2003). This review provides a brief overview of studies that have examined the efficacy of student-centered learning in STEM education.

In a meta-analysis of 225 studies, Freeman et al. (2014) evaluated instructional methods in undergraduate science, technology, engineering, and mathematics (STEM) classes to investigate the impact of active learning on students. The analysis demonstrated that student performance on examinations or concept inventories was about 6% greater with active learning instruction. Analysis also demonstrated that students were 1.5 times more likely to fail if enrolled in a traditional lecture class rather than a class that utilized active-learning principles. Similarly, Prince (2004) reviewed the literature base on active learning in engineering education, and although he found some studies that yielded a null effect, he concluded that there was sufficient compelling evidence in favor of the efficacy of student-centered learning to advocate for reforming engineering education. Ultimately, student-centered learning has proven to be a more effective teaching method for promoting learning in engineering classrooms.

Gender-based Preferences for Learning

While it has long been known that multiple modalities of instruction can appeal to various learners (Kolb, 1976), there also exists evidence that there are distinctions in learning preferences based on gender (Kulturel-Konak, D'Allegro, & Dickinson, 2011). Because the correspondence between learning preference and classroom environment has a significant impact on student outcomes, it is important to consider the implications of different learning preferences by gender. For example, Philbin et al. (1995) conducted a study based on Experiential Learning Theory (ELT) (Kolb, 1976) to determine if there were differences in learning preferences by gender. The authors found that men were more than twice as likely to prefer reading, lectures, and analytical models in a formal learning environment, whereas women were less likely to share these preferences but were three times more likely than men to prefer working in groups and listening to different points of view.

Kulturel-Konak, D'Allegro, and Dickinson's study (2011) of learning preferences of over 300 undergraduate students yielded similar findings. Across STEM and non-STEM majors, a key finding of the study was that women preferred collaboration and cooperation over competition, which was favored by men. Additionally, women tended to opt for creative materials whereas men mostly wanted concrete materials for learning course subject matter, which is the most common method utilized in classroom instruction. These results support the findings of other research indicating that women were more likely to relate to "connected knowledge," which is more empathetic and interpersonal (Belenky, Clinchy, Goldberger, & Tarule, 1986).

Despite differences in preferred learning styles between genders, student-centered teaching practices have been proven to benefit students of all genders in the classroom. Dym et al. (2005) observed that project-based learning, which is linked to active-learning practices, improved learning outcomes for all engineering students, while Patterson, Campbell, Busch-Vishniac, & Guillaume (2009) found that contextualizing class materials inclusively benefits both male and female students' learning in engineering classrooms. It can be concluded that student-centered teaching has the potential to improve all engineering students' understanding and learning.

Gender Differences in Faculty Teaching Approach

Though limited, there is a growing body of literature exploring the different pedagogical practices employed by male and female faculty members. Studies show that female faculty members generally have a higher motivation for teaching (Bailey, 1999) whereas men tend to be more research-oriented (Schuster & Finkelstein, 2006). Possibly related are the findings that female faculty members are more likely to have positions that include greater teaching duties than men (Schuster & Finkelstein, 2006) and that women faculty members are represented more highly at teaching colleges and universities than at research institutions (Winslow, 2010).

Female faculty members also tend to have higher student enrollment in their classes and more students to advise or mentor than men (Bird, Litt, & Yong, 2004; Hart & Cress, 2008). Men are more likely to teach vanity courses with small enrollments, meaning women are generally more often responsible for the larger core courses (Hart & Cress, 2008). It has additionally been revealed that "female faculty are more likely to approach teaching and learning [by] reviewing the scholarly and pedagogy literature, discuss their ideas and experiences with other faculty and colleagues, and … consult and interact with experts" (Myers, 2008, p. 47).

How men and women allocate class time in higher education has also been studied broadly. In an examination of National Study of Postsecondary Faculty data, Winslow (2010) found key distinctions between allocations of teaching time by female and male faculty members. The results indicated that female instructors prefer to spend a larger percentage of their time on teaching than men, and that women spent more time on teaching each working week than male instructors. Similarly, Laird, Garver, and Niskodé-Dossett (2011) analyzed faculty responses from over 100 higher-education institutions and found that men spent more time on lecturing while women spent a larger proportion of class time on student-centered teaching strategies.

Regarding teaching style, Lacey, Saleh, and Gorman (1998) found that both male and female faculty members placed a strong emphasis on sensitivity. However, analysis showed that female faculty members were more likely to let students discover their own preferred learning methods and were very student-centered oriented, whereas male faculty members tended to be more rigid and believed that they knew what was best for students, regardless of students' learning preferences. Cress and Hart (2009) reviewed teaching styles regarding faculty members' propensity to lecture, finding that male instructors were significantly more likely than women to give extensive lectures (64% v. 38%, respectively). This study also revealed that male faculty members were more likely than female instructors to have teaching assistants for their courses (30% and 19%, respectively), despite the discrepancy of women typically having greater teaching loads. These results are aligned to Singer's (1996) findings that women faculty members are more likely to invest time in planning course content and assessing student learning than their male counterparts, and that male instructors tend to utilize a teaching paradigm that is content-focused rather than student-oriented.

While some generalizations can be drawn from existing literature, it is important to know what, if any, gender-based differences exist among engineering faculty regarding the use of student-centered strategies and attitudes regarding those strategies. What is generally known from the research is that female faculty members typically spend a greater amount of time preparing course materials and are more likely to utilize student-centered instruction than their male colleagues. However, there is still much to be learned about differences between male and female faculty members' use of, and attitudes towards, student-centered teaching strategies, particularly in engineering education.

THEORETICAL FRAMEWORK

Expectancy theory, which developed from motivational theorists, is a conceptual framework that attempts to explain people's choice of actions. More specifically, the theory posits that individuals' choice to perform a task depends on two factors: how well they expect to do on a particular task and how much they value the activity (Wigfield & Eccles, 2000). Therefore, a person will be disinclined to attempt an activity, or will have low motivation to perform a task, if they do not see a likely chance of success or if they do not value the activity or process.

A main tenet of expectancy theory is the anticipated outcome of a perceived task, or expectation. The expectation is the individual's belief or predicted result at the end of a task. Expectancy is related to self-efficacy and perceived self-ability to succeed in a particular project or subject (Bandura, 1997; Wigfield & Eccles, 2000). Therefore, an individual's perceived expectation of whether or not a task will yield a successful outcome plays a critical role in their decision to act toward achieving the end goal.

A second seminal component of expectancy theory is value, which is related to expectation of success. The expected outcome of an activity will influence the value one places on achieving the outcome or task (Shah & Higgins, 1997). When determining the value of a particular task, individuals consider both the predicted effort and the anticipated value of achieving the task (Shu & Lam, 2011). Thus, value can be thought of as the sum of both inputs and outputs. The inputs are often considered *costs*, and the weight educators place on these input costs can heavily influence decisions to exert effort and attempt a new pedagogical practice (Ertmer, 1999). In designing the current study, costs (inputs) were considered to be their own construct, independent from the output of value.

Expectancy theory has been traditionally studied from the student perspective. However, some researchers (e.g. Ertmer, 1999; Mueller et al., 2008) have used these concepts to examine the role of the theory as it pertains to the instructional practices of teachers. The current study focused on the beliefs of faculty members about the expectation of success, value (output of achieving a task), and costs (necessary inputs) related to certain teaching strategies.

METHODOLOGY

Sampling and Administration

The sample for this study was drawn from 19 of the 20 largest engineering courses provided by four-year institutions in the United States, listed in a report published by the American Society for Engineering Education (Yoder, 2014). The authors' institution is one of those 20 largest colleges but was not included in the survey administration. These institutions were selected so that the responses of their faculty members could later be compared with the responses of faculty members at the authors' institution who participate in an ongoing faculty professional development program.

The invitation to complete the survey regarding undergraduate engineering instruction was sent via email to approximately 6,300 email addresses, which were collected from the websites of the engineering colleges. Because the request was sent to all available email addresses of engineering faculty members listed on college websites, and many of those email addresses were associated with faculty who do not teach undergraduate courses, it is not possible to determine the response rate. A total of 286 engineering faculty members responded to the survey – enough to test the validity and reliability of the instrument (Cronbach's α=.9) and to allow substantial analysis in order to determine usage of, and dispositions towards, student-centered pedagogical strategies.

Survey Instrument

The Value, Expectancy, and Cost of Testing Educational Reforms Survey (VECTERS) was designed, validated (Judson, Ross, Middleton, & Krause, 2017), and used to determine faculty dispositions about and use of three specific classroom strategies:

1. Using *formative feedback* to adjust instruction
2. Integrating *real-world applications*
3. Facilitating *student-to-student discussions* in class

The VECTERS instrument design was based on the tenets of expectancy theory (Shah & Higgins, 1997; Shu & Lam, 2011; Wigfield, Tonks, & Eccles, 2004). The instrument assessed faculty beliefs about the student-centered learning strategies along three specific constructs: value, expectancy, and cost.

Value: The construct of value is closely related to benefit. The questions related to value sought to determine if respondents viewed each classroom strategy as having a potential benefit or a detrimental effect for either the students or the instructor.

Expectancy: This construct examined the expectation of what would happen in the learning environment if a particular teaching strategy was implemented. These questions focused on the perceived outcomes, either successful or unsuccessful, within the classroom. The expectancy questions had three main areas of focus:

expectancy related to students' success, instructor capabilities, and the physical environment of the classroom.

Cost: The cost questions examined perceived expense for implementing a particular pedagogical strategy. Cost was conceptualized as an allocation decision encountered when an instructor determined how best to use limited resources of materials, time, teaching assistants (if available), and personal effort.

The structure of VECTERS was adapted from the work of Abrami, Poulsen, and Chambers (2004), who investigated the use of collaborative learning among secondary teachers. For each of the three classroom strategies, VECTERS contains parallel items: 11 value items, 10 expectancy items, and 5 cost items. Instructors were asked to indicate their level of agreement on a four-point Likert scale on the 26 items in the context of each classroom strategy. This resulted in 78 total items for the three pedagogical strategies. Example items from VECTERS are provided in Table 1.

Finally, respondents were asked to indicate use of each strategy. This was measured in two ways: *current use*, where faculty indicated to what extent they currently used that strategy/tool in their classroom practices, and *future use*, in which faculty estimated the extent to which they would use that strategy in the future.

Table 1: VECTERS Example Items

Example items	**Formative feedback (collecting ongoing feedback from students and altering instruction throughout the semester based on feedback)**	**Real-world applications (demonstrating relevance, integrating real-world problems, underscoring connections to industry and design)**	**Instructor initiated student-to-student discussions during class (focused on furthering understanding)**
Value item: Use of the strategy/tool helps students to obtain a deeper understanding of the material	1 2 3 4	1 2 3 4	1 2 3 4
Expectancy item: Use of this strategy/tool may make class too chaotic	1 2 3 4	1 2 3 4	1 2 3 4
Cost item: It is very difficult to implement this strategy/tool without specialized materials	1 2 3 4	1 2 3 4	1 2 3 4

Demographic Information of Participants

Key demographic information was collected, including years of teaching experience, position/title, gender, race, and ethnicity. The demographic characteristics, disaggregated by gender, of the 286 respondents are presented in Table 2.

Table 2: Instructor Demographic Information Percentages, by Gender

	Female	Male
	27.6%	72.4%
Years Teaching		
1–3	24.1	10.1
3–5	12.7	6.3
5–10	19.0	13.5
10–15	19.0	12.6
15–20	15.2	13.5
20–25	5.1	6.8
>25	5.1	37.2
Position[1]		
Teaching assistant	1.3	0
Adjunct/Adjunct professor	1.3	2.4
Lecturer/Instructor	8.9	7.8
Clinical professor	1.3	1.0
Professor of practice	3.8	4.8
Research professor	2.5	1.9
Assistant professor	26.6	12.1
Associate professor	25.3	17.9
Professor	22.8	50.2
Other	5.1	0.5
Race		
Asian	5.1	4.8
Black	1.3	1.4
White	89.9	88.4
Mixed	2.5	1.0
Ethnicity		
Hispanic or Latino/a	3.8	5.3
Not Hispanic or Latino/a	94.9	93.2

[1]Classification of positions corresponds to faculty ranks in the United States.

Of the 286 respondents, 79 (27.6%) identified as female and 207 (72.4%) identified as male. This signifies an overrepresentation of women in this sample, as compared to the 15.2% of female engineering instructors across the United States (Yoder, 2014). This overrepresentation of female respondents could be due to a few different factors. First, it could be due to women being more represented than men in teaching institutions and roles (Schuster & Finkelstein, 2006; Winslow, 2010) and therefore being more likely respond to surveys regarding pedagogical practices. Second, it could also could be because women are generally more enthusiastic about teaching (Bailey, 1999) and have a greater motivation to respond to studies on that topic.

Respondents were asked to think about one undergraduate engineering course they had taught within the past 18 months when answering the survey questions. This timeframe was selected so that instructors would consider only relatively recent courses and to accommodate instructors at institutions with various schedules (e.g. trimester, quarter). Instructors identified the level of the course, 100 to 400 (Table

3). Respondents also indicated whether or not the course they were reporting on was required for the major, as well as average course enrollment (Table 3).

Table 3: Course Level Percentages, by Instructor Gender

Course Level	Female	Male
100	19.0	9.7
200	20.3	16.4
300	36.7	39.1
400	24.1	34.3

Table 4. Mean Number of Students, by Instructor Gender

	Female			Male		
Level	Required n=61 (77%)	Not Required n=18 (23%)	All n=79 (100%)	Required n=155 (76%)	Not Required n=48 (24%)	All n=207 (100%)
100	75.7	85.8	78.4	79.0	94.8	80.8
200	107.9	50.0	100.6	83.8	107.5	85.2
300	71.0	50.0	70.3	70.8	57.3	69.5
400	56.8	60.3	58.6	61.5	38.9	51.5
All Levels	**78.5**	**64.2**	**75.2**	**71.8**	**51.4**	**66.9**

Data Analysis

Analysis in this study was focused on determining what differences, if any, existed between responses of male and female faculty members. Broadly, the intent was to determine if gender-based differences existed regarding use of strategies and attitudes towards the specific strategies. A two-step process was employed. First, influence of three variables – years of teaching experience, class size, and course level – were evaluated to determine their effect on the outcome of using specific strategies. Next, after controlling for these variables, a series of multivariate analyses of covariance (MANCOVAs) were conducted to evaluate usage and disposition differences based on gender.

RESULTS

Use of Strategies

Pearson correlation analyses were conducted to determine the strength of relationships between teaching experience, class size, and course level as they relate to both current and planned use of the three classroom strategies. Examining each variable across the entire dataset, the principal findings for each variable were as follows:

- No significant relationships were found to exist across the data between years of teaching and current or planned use of any of the three strategies ($p > 0.05$).
- The number of students in a class had a significant and negative relationship only with current use of real-world applications ($r = -.133$, $p < .05$).
- There was a significant relationship between course level and use of real-world applications ($r = .237$, $p < .001$).

These overall findings indicate that faculty members are more likely to integrate real-world applications into upper division courses, particularly if these courses have fewer students. However, this initial analysis did not account for the marked gender differences in the composition of faculty. As indicated in Tables 2, 3, and 4, in this sample, female faculty had been teaching fewer years, were more likely to be teaching lower division courses, and taught classes with more students. Therefore, in addition to addressing the research questions, and because of these gender-based differences in the sample, it is important to account for gender in the analysis of the data.

Disaggregation of data by gender provided greater detail of the effect of number of students, years of teaching, and course level on reported use of, and attitudes towards, the student-centered learning strategies. Data from female faculty members revealed significant correlations between the number of students in a class and the current use of formative feedback (r = .241, $p < .05$) and planned use of formative feedback (r = .239, $p < .05$). Although this finding is counterintuitive at first glance, it implies that female faculty members with larger student enrollments are more likely to integrate formative feedback deliberately into their instructional practices.

Among the responses from women, a significant relationship also existed between course level and use of real-world applications (r = .294, p = .009). This indicates that female instructors are inclined to integrate real-world applications more in upper division courses than in lower division courses.

Due to the greater number of male respondents in the dataset, the relationships found among data from male faculty members were similar to those from analysis of all respondents – that is, a significant negative relationship was found to exist between student course enrollment with reported current use of real-world applications (r = -.155, $p < 0.05$) and planned use of real-world applications (r = -.148, $p < .05$). This indicates that male instructors with large classes are less likely to integrate real-world applications than those with smaller enrollments. A significant relationship also existed between course level and use of real-world applications (r = .232, $p < .01$).

A series of MANCOVAs were conducted for the dependent variables of current use and planned use of the three classroom strategies with teaching experience, class size, and course level applied as covariates and gender placed as a fixed factor. Analysis of how faculty members reported both current and planned future use of the three strategies resulted in only one out of the six outcomes yielding a significant difference between men and women. Specifically, women reported significantly greater current use of real-world applications than men (F(1, 269), $p < .05$).

Gender Comparison of Dispositions

Gender-based differences in dispositions (value, expectancy, cost) were then examined regarding the three classroom strategies. Table 5 provides Pearson correlations between mean scores for the constructs of value, expectancy, and cost, with the reported level of current use and planned use. The negative correlations in the Cost column of Table 5 suggest that increasing usage of the strategies was associated with the belief that they had decreasing implementation costs.

Table 5: Correlations: Implementation with VECTERS Constructs

		Value		Expectancy		Cost	
Strategy	**Use**	Female	Male	Female	Male	Female	Male
Formative feedback	Current	.64**	.58**	.63**	.49**	-.36**	-.38**
	Future	.63**	.60**	.53**	.49**	-.37**	-.30**
Real-world application	Current	.34**	.47**	.33**	.34**	-.26**	-.28**
	Future	.36**	.41**	.28*	.23**	-.19	-.12
Student-to-student discussion	Current	.55**	.61**	.53**	.57**	-.49**	-.44**
	Future	.57**	.61**	.58**	.57**	-.39**	-.41**

*$p < 0.05$. **$p < 0.01$.

Table 6 provides descriptive statistics of reported dispositions. VECTERS items are rated on a four-point Likert scale ("strongly disagree" to "strongly agree"), with low ratings (1) indicating that the respondent believes the strategy has low value, does not expect success, and believes the strategy has low cost.

Table 6: Mean and Standard Deviation Construct Scores, Females (n=77) and Males (n=195)

	Value		Expectancy		Cost	
Strategy	Female	Male	Female	Male	Female	Male
Formative feedback	3.10	2.90	3.41	3.17	2.20	2.24
	.54	.55	.44	.52	.68	.61
Real-world applications	3.46	3.31	3.59	3.47	2.22	2.16
	.36	.41	.34	.42	.62	.61
Student-to-student discussion	3.18	3.06	3.21	3.06	2.13	2.14
	.57	.52	.58	.57	.62	.67

Although Table 6 suggests men and women responded very similarly, MANCOVAs revealed some significant differences after controlling for course size, years of teaching experience, and course level. The elements of value, expectancy, and cost were designated as dependent variables, with the covariates of teaching experience, class size, and course level applied.

The results in Table 7 indicate that gender had a significant effect on outcomes ($p < .05$) in four of nine categories after controlling for the effect of these variables. Women were significantly more positive regarding expectation of success and placed significantly greater value on the strategies of using formative feedback and real-world applications. The effect size, as measured by partial-eta squared (η_p^2), is considered small, implying effects that are real but difficult to detect.

Because the constructs of value and expectancy on VECTERS comprise items that can be logically categorized, we further analyzed those subcategories. The 11 value items were categorized as items indicating that a strategy has value for students (8 items) or has value for the instructor (3 items).

Table 7: Significant ANCOVA Gender-Based Differences

	F (1, 267)	***p***	**partial eta-squared**
Formative feedback – value	4.41	.037	.016
Formative feedback – expect success	9.73	.002	.035
Real-world applications – value	6.09	.014	.022
Real-world applications – expect success	7.32	.007	.027

Similarly, expectation of success (i.e. expectancy) items could be categorized as expecting success due to students (5 items), instructor ability (2 items) and physical environment (2 items). Again, controlling for course size, years of teaching experience, and course level, significant differences were discovered. In all cases, women had more positive dispositions than men. Table 8 summarizes only those categories in which statistically significant differences were found.

Table 8: Significant ANCOVA gender-based differences of subcategories

	F (1, 267)	***p***	**partial eta-squared**
Formative feedback – value for students	8.90	.003	.033
Formative feedback – expect success due to students	7.26	.008	.027
Formative feedback – expect success based on self	11.66	.001	.043
Real-world applications – value for students	6.53	.011	.024
Real-world applications – expect success due to students	5.94	.015	.022
Student discussions – expect success due to students	5.22	.023	.020

DISCUSSION

Outcomes of this study provide both anticipated and unexpected results. Multiple studies that broadly examined faculty practices in higher education (Cress & Hart, 2009; Lacey, Saleh, & Gorman, 1998; Laird, Garver, & Niskodé-Dossett, 2011; Singer, 1996) found that female faculty members are more likely to utilize student-centered teaching practices. However, in answer to the first research question regarding use of strategies, the results of this study indicated few gender-related differences regarding how often student-centered strategies were used by engineering instructors. Women reported using real-world applications more often than men, but there were no differences in the use of formative feedback or student-to-student discussions. Men and women also indicated no differences regarding their plans to use these strategies in the future. In general, although female faculty members possessed more positive views about student-centered teaching strategies, reported use of strategies was the same across male and female faculty members.

What was more revealing were the multiple significant gender differences when dispositions were analyzed (Tables 7 and 8) to address the second research question regarding gender-based differences in attitudes towards the three student-centered strategies. These results indicated that female participants were significantly more confident regarding the value of both real-world applications and formative feedback, and that women faculty members expected success to emerge from the use of these strategies more than their male colleagues. Furthermore, women respondents were more likely to expect success due to students in the class, as opposed to themselves, across all three strategies. However, women and men respondents considered the costs of implementing student-centered strategies to essentially be the same. These findings regarding different dispositions seem to counter the reported equivalent use of the strategies. This may imply that men have less optimistic attitudes, but it also points toward the need for on-the-ground research wherein classroom teaching practices are observed.

The attitudinal results are consistent with previous research (Cress & Hart, 2009; Laird, Garver, Niskodé-Dossett, 2011; Singer, 1996; Winslow, 2010). While some general studies have examined pedagogical differences between male and female instructors, there have been few studies that have looked at these differences in STEM and, even more specifically, undergraduate engineering education. Thus, this study adds to the current literature base on the practices and beliefs of undergraduate engineering faculty members.

This study also contributes to the understanding that there are gender-based differences between instructors' teaching strategy preferences. It indicates that the more positive attitudes of female instructors may have a notable impact on student learning and achievement, since students are apt to be receptive to instructors who believe in the efficacy of student-centered strategies and are not just integrating them into class because such a strategy is nothing more than a trend.

CONCLUSION

The findings from this study point to a need for further research that focuses on gender differences among engineering faculty members and consequential effects on students. While we know that women are underrepresented as students in the engineering disciplines, and that they generally possess different learning preferences than male students, we now have evidence indicating varying gender-based penchants among faculty members for different classroom practices. Further research studies could illuminate gender-based differences among both faculty and students in order to better understand ways to serve both populations in the future.

The findings also pose the question of *why* dispositions about teaching are so different between male and female engineering faculty members. Possible underlying reasons include varying personal learning preferences, expectations from students, and/or feedback from administrators. For example, attitudes may be affected by perceived levels of support from administrators for teaching versus scholarship, particularly if women are complimented more often for teaching, or tasked with more teaching and mentoring responsibilities, and men are praised more often for research. Though outside the scope of this study, the reasons for varying dispositions about teaching between men and women warrants further investigation. Future research to gain insight into this area could have important implications for scholarship, understanding of teaching practices, and implementation of different pedagogical strategies.

Another possible research area to explore is the reasons for the gender-based differences found in this study. For instance, what are other gender-based differences among faculty members, in STEM and other disciplines? Why are women more likely to be placed in teaching than research roles? What are the implications of women being in more teaching-centered positions? How does this impact the careers of female faculty members? Should there be an increased emphasis on the value of teaching for faculty? And are there differences in student performance based on instructor gender?

In sum, it was found that, even though female faculty members often possessed more positive views about student-centered practices than male faculty members, the reported use of student-centered strategies was nearly equivalent between men and women, although women reported significantly greater use of real-world applications. These findings raise questions regarding whether dispositions affect the fidelity and quality of implementation of student-centered strategies. If attitude affects practice, it can be conjectured that, although male and female faculty mostly report similar use of student-centered strategies, women may be integrating these strategies with greater enthusiasm and quality. Further research, particularly in the classroom, should be conducted to better understand if attitude affects fidelity or quality of integrating student-centered teaching practices in the classroom, while also examining how this impacts student achievement.

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