How do Male and Female Faculty Members View and Use Classroom Strategies?

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Abstract

Research indicates differences exist between male and female students regarding preferences for various pedagogical practices, such as collaborative learning. Additionally, we know that students may construe an instructor's gender as influencing their capacity to be role models, teach effectively, and produce scholarship. Less well known is how male and female instructors view specific classroom strategies, as well as how often they use those strategies. To aid understanding, the newly developed Value, Expectancy, and Cost of Testing Educational Reforms Survey (VECTERS) was applied. VECTERS was based on expectancy theory, implying instructor decisions to integrate, or not integrate, classroom strategies are based on (1) perceived value for both students and self, (2) expectation of success, and (3) perceived implementation costs (e.g., time, materials).

Responses were collected from 286 engineering faculty members (207 male, 79 female) from 19 institutions. Responses indicated frequency of use, perceptions of value, expectation of success, and cost (e.g., use of TA's, materials) for these classroom strategies:

1. Formative feedback loops
2. Real-world applications
3. Facilitating student-to-student discussions

Controlling for course enrollment and years of experience, several significant differences were found. Gender did not differentiate reported use of the strategies, but there were significant differences ($p < .05$) related to the expectation of success when integrating formative feedback and real-world applications. Women had significantly higher mean scores related to expectations of success for the implementation of formative feedback and real-world applications; however, effect sizes were small (partial eta-squared < .04). Similarly, women indicated that using the strategies of formative feedback and real-world applications had significantly greater value. Also, men were significantly more inclined to view the physical setup of their classroom as hindering implementing formative feedback or initiating student-to-student discussions. There were no differences in perception of costs for any of the strategies between male and female instructors.

Introduction

The traditional lecture format, which is also referred to as content-oriented instruction, is the primary teaching method in undergraduate engineering classrooms.[1] Student-centered instruction, or active learning, involves activities during the class that directly involves student participation. There has been a growing emphasis on employing student-centered teaching strategies in the classroom because evidence indicates they are a more effective and engaging way for students to learn course materials.[2]

Recent empirical studies have investigated the pedagogical approaches utilized by faculty members in the classroom. While some studies have examined the differences in teaching strategies between male and female faculty members, there is still much to be learned. Of particular interest is if male and female engineering instructors approach teaching differently, specifically regarding student-centered or content-oriented instruction.

In this study we sought to determine the gender-based differences of faculty members' use of, and dispositions towards, student-centered learning strategies. This study was framed by these 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 student-centered strategies in engineering education?

Review of Related Research

Student Centered Teaching Strategies in Engineering Education

Many empirical studies have been conducted to better understand the effectiveness of student-centered learning in higher education. These studies have demonstrated that student-centered instruction promotes greater learning and understanding compared to traditional content-oriented strategies.[3,4] This review provides a brief overview of studies that that have examined the efficacy of student-centered learning in STEM education.

In a meta-analysis of 225 studies, Freeman et. al evaluated instructional methods in undergraduate STEM classes to investigate the impact of active learning on students.[2] The analysis demonstrated student performance on examinations or concept inventories was greater, at about 6%, 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 utilizes active learning principles. Similarly, Prince reviewed the current literature base on active learning in engineering education.[5] Although Prince found some studies that did not show a benefit for student-centered instruction, the researcher concluded that engineering instructors should consider active learning, as some of the research is compelling and will encourage faculty members to think about new methods of instruction.

Different Preferences for Learning by Gender

Research studies have demonstrated that students learn differently.[6] There are also distinctions between learning preferences based on gender.[7] Because the correspondence between learning preference and learning environment has a significant impact on learning outcomes, it is important to consider the implications of different learning styles by gender.

Kolb developed the Experiential Learning Theory (ELT) as a means to understand the four stages of the learning cycle, as well as the differences between how people learn. The ELT suggests that learning does not happen just from transmission of information from teacher to student, but rather that learning is a process created by the individual learner.[8] Within ELT, learning style is defined as the preferred method for individuals to understand and develop knowledge through learning experiences.

Through the ELT, Kolb developed the Kolb Learning Style Inventory (KLSI), which was greatly influenced by the works of Dewey, Lewin, & Piaget.[6] The KLSI assesses the different ways that people acquire and understand information, resulting in four distinct learning styles:

1. *Accommodator*: People with this learning style prefers "hands-on" experience. They rely on intuition for decision making, and also rely on other people for information, rather than conducting their own analysis.
2. *Assimilator*: People with this learning style prefer reading, lectures, and analytical models in formal learning environments. They are more focused on ideas or concepts, rather than other people.
3. *Converger*: People with this learning style excel at finding practical implications for ideas. They prefer technical tasks to social or interpersonal issues. They learn through experimentation with new ideas, through simulations or laboratory experiments.
4. *Diverger:* People with this learning style prefer working in groups and listening to different points of view. They are emotional, imaginative and have broad cultural interests. They perform well in tasks that call for brainstorming new ideas.

Philbin, Meier, Huffman, and Boverie conducted a study, based on ELT, to determine if there were differences in learning styles by gender.[9] The authors found that men were more than twice as likely to have an assimilator learning style, implying a preference for reading, lectures and analytical models in a formal learning environment. Women were least likely to possess an assimilator learning style, but were more than three times more likely than men to possess a diverger learning style which implied a preference for working in groups and listening to different points of view. Kulturel-Konak, D'Allegro, and Dickinson yielded similar findings in a study of learning preferences of over 300 undergraduate students.[7] Across STEM and non-STEM majors, a key finding was that women prefer collaboration and cooperation over competition, which is favored by men. Additionally, women favored creative materials; whereas men mostly wanted concrete materials, which is most commonly used in classroom instruction. These results support the findings of Belenky, Clincy, Goldberger, and Tarule, which stated that women were more likely to relate to "connected knowledge,"[10] which is more empathetic and interpersonal.

Perception of Male and Female Instructors

Sprague and Massoni revealed that students significantly view their male and female instructors differently.[11] A key finding showed that students expect more intensive teaching from women faculty. It was also found that spontaneous was a word used to describe male instructors, but not female teachers, which could imply that women do more work outside of class to prepare instructional materials. The most common word used to describe male and female teachers was "caring." The other top two words for the male faculty members were "understanding" and funny;" and the other words for the female faculty were "helpful" and "kind." It is interesting to note that those two words for men describe characteristics of a person, whereas the words for women indicate what a person does. Words indicating nurturing and sensitive faculty members were used at a much higher rate for female instructors.

Gender Differences in Faculty Teaching Approach

Beyond some studies related to the perception of students about faculty, there is a scarcity of research regarding actual differences in male and female instructors. Studies show that female faculty members generally have a higher motivation for teaching;[12] whereas men are more research oriented.[13] Possibly associated are the findings that female faculty members are more likely to have positions that include more teaching duties than men;[13] and women are more represented at teaching institutions, rather than research institutions.[14]

Female faculty members are also more likely to have heavier student loads and have more students to advise or mentor than men.[15,16] Men are more likely to teach "vanity courses with small enrollments" which means women are more often responsible for the larger core courses.[15] It has also been revealed that "female faculty are more likely to approach teaching and learning reviewing the scholarly and pedagogy literature, discuss their ideas and experiences with other faculty and colleagues, and to consult and interact with experts."[17]

How men and women allocate class time has also been studied broadly in higher education. In an examination of National Study of Postsecondary Faculty data, Winslow found key distinctions between time allocation of female and male faculty.[14] The results indicated that female instructors prefer to spend a larger percentage of their time on teaching than men. The study also revealed that women spent more actual time on teaching each workweek than male instructors. Laird, Garver, and Niskodé-Dossett analyzed faculty responses from over 100 higher education institutions and found that men spent more time on lecturing, and that women spent a larger proportion of class on student-centered teaching strategies.[18]

Regarding teaching style, Lacey, Saleh, and Gorman found that both male and female faculty members place a strong emphasis on sensitivity.[19] However, analysis showed that female faculty members were more likely to let students discover their own learning style and were very student-center 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. Teaching style was conceived in terms of propensity to lecture by Cress and Hart who found that male instructors are significantly more likely to give extensive lectures than women (64% v. 38%, respectively).[20] This study also revealed that male faculty were more likely than female instructors to have teaching assistants for their courses (30% and 19%, respectively). These results are aligned to Singer's findings that women faculty members are more likely to invest time in planning course content and assessing student learning; and that male instructors are more likely to utilize a teaching paradigm that is content-focused, rather than student-oriented.[21]

What we generally know from the research is that female faculty members typically spend more time preparing course materials and they are more likely to utilize student-centered instruction. Absent from the research is a focus on engineering. 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.

Methodology

This study was conducted to better understand gender-based differences of faculty dispositions towards student-centered teaching strategies. In order to investigate this topic an online survey instrument was utilized to collect data from faculty at the largest colleges of engineering across the country.

Sample & Administration

The sample for the survey was drawn from 19 of the 20 largest colleges of engineering at four year institutions, which was determined through a report published by the American Society for Engineering Education.[22] The authors' institution is one of the 20 largest colleges and was not included in the survey administration. The 19 largest schools were selected in order to compare responses with the faculty members at the authors' institution that participate in an ongoing faculty professional development program.

The invitation to complete the survey regarding undergraduate engineering instruction was sent via email. Email addresses were collected from the websites of the engineering colleges. The invitation was sent to approximately 6,300 email addresses. 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. While this response is low, it was deemed suitable to test the validity of the instrument and 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, and used to determine faculty dispositions about 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.[23,24,25] While expectancy and motivation are usually described from the student perspective, this study focused on the beliefs of faculty members about the expected inputs and outputs of the three pedagogical strategies mentioned above. A key component of this theory is the relationship among the expectancy of success, the value that individuals place on attainment, and the perceived cost to implement.

> *Value:* The construct of value is closely related to benefit. The value items sought to determine if respondents viewed each classroom strategy as having potential benefit or a detrimental effect for either the students or the instructor.
>
> *Expectancy*: This construct examines the expectation of what will happen in the learning environment when a particular teaching strategy is implemented. These items focused on the perceived outcomes, either successful or unsuccessful, within the classroom. The expectancy items have three main areas of focus: expectancy related to students' success, instructor capabilities, and the physical environment of the classroom.

Cost: The cost items examine perceived expense for implementing a particular pedagogical strategy. The cost questions address time, use of teaching assistants' time, and overall effort required to implement each strategy.

The structure of VECTERS was adapted from the work of Abrami, Poulson, and Chambers who investigated the use of collaborative learning among secondary teachers.[26] 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, resulting in 78 total items for the three pedagogical strategies.

Demographic Information of Participants

Of the 286 respondents, 79 identified as female and 207 identified as male. Comparing respondent information with national statistics revealed an interesting comparison. A report published by ASEE indicates female faculty, both tenure and non-tenure, account for 15.2% of engineering instructors. But, survey respondents were comprised of 27.6% female respondents. The relative overrepresentation of responses from female faculty could be due to women being more likely to use student-centered practices, and thus more inclined to participate in the survey. Key demographic information were collected, including years of teaching experience, position/title, race, and ethnicity. This demographic information was disaggregated by gender (Table 1).

Table 1. Instructor Demographic Information, by Gender.

		Female (n=79; 27.6%)	Male (n=207; 72.4%)
Years of teaching experience	1 - 3 years	24.1%	10.1%
	3 - 5 years	12.7	6.3
	5 - 10 years	19.0	13.5
	10 - 15 years	19.0	12.6
	15 - 20 years	15.2	13.5
	20 - 25 years	5.1	6.8
	> 25 years	5.1	37.2
Position	Teaching Assistant	1.3	0
	Adjunct / Adjunct Prof	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	3.8	5.3
	Not Hispanic or Latino	94.9	93.2

Respondents were asked to think about one undergraduate engineering course they had taught within the past 18 months when answering the survey questions. Instructors identified the level of the course, 100 to 400 (Table 2). Instructors 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 2. Course Level, by Instructor Gender.

		Female (n=79)	Male (n=207)
Level of course participant focused on	100	19.0%	9.7%
	200	20.3	16.4
	300	36.7	39.1
	400	24.1	34.3

Table 3. Mean Number of Students, by Instructor Gender.

		Female (n=79)			Male (n=203)		
	Level	Required Course n=61, 77%	Not Required n=18, 23%	All	Required Course n=155, 76%	Not Required n=48, 24%	All
Level of course participant reported on	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	78.5	64.2	75.2	71.8	51.4	66.9

Data Analysis

Analysis in this study was focused on determining what, if any, differences existed between male and female faculty responses. Broadly, we wanted to determine if gender-based differences existed regarding (1) use of strategies and (2) dispositions regarding strategies.

We followed a two-step process. First we evaluated the influence of three variables to determine their effect on the outcome of using specific strategies. The variables examined were years of teaching experience, class size, and course level.

Next, 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 analysis were conducted to determine the mitigating effects of 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 following are the principal findings per each variable:

- 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.
- The number of students in a class had a significant and negative relationship only with current use of real-world applications ($r = -.133$, $p = .025$).
- There was a significant relationship between course level and use of real-world applications ($r = .237$, $p < .001$).

These overall findings indicate faculty members were more apt to integrate real-world applications into upper division courses, particularly if they have fewer students. However, this initial analysis did not account for the marked gender differences in the composition of faculty. As indicated in Tables 1, 2, and 3, in this sample, female faculty had been teaching fewer years, were more likely to be teaching lower division courses, and taught classes with larger enrollment.

Disaggregation of data by gender provided greater detail of the effect of number of students, years of teaching, and course level. Data from female faculty revealed significant correlations between the number of students in a class and the current use of formative feedback (r = .241, p = .033) and planned use of formative feedback (r = .239, p = .035). This implies that female instructors with large classes are more likely to use formative feedback than those with smaller classes. Although this finding is at first glance counterintuitive, it implies that female faculty members with larger student enrollments are more likely to deliberately integrate formative feedback 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 women instructors are more inclined to integrate real-world applications in upper division courses than in lower division courses.

Due to the greater amount of male respondents in the dataset, the relationships found among male faculty data were similar to those from analysis of the entire dataset. 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 = .027) and planned use of real-world applications (r = -.148, p = .036). 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 = .001).

A series of MANCOVAs were conducted for the dependent variables of current use and planned use for 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 often faculty members reported using (currently using and planned to use) the three strategies resulted in only one out of the six outcomes yielding a significant difference between men and women. Women reported significantly greater current use of real-world applications than men, F(1, 269), p = .04.

Dispositions (Value, Expectancy, and Cost) – Gender Comparison

Gender-based differences in dispositions (value, expectancy, cost) were then examined regarding the three classroom strategies. Table 4 provides Pearson correlations between mean scores for the constructs of value, expectancy and cost, with the reported level of implementation of the strategy, i.e., current use and planned use. The negative correlations in the cost column of Table 4 imply that high usage of the strategies was associated with belief that the strategies had relatively lower implementation costs.

Table 4. Correlations (r-value): Implementation with VECTERS Constructs

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

* significant at 0.05 level ** significant at 0.01 level

Table 5 provides descriptive statistics of reported views. VECTERS items are rated on a 1 to 4 scale with low ratings of a 1 indicating the respondent believes the strategy has low value, does not expect success and believes the strategy has low cost.

Table 5. Mean VECTERS scores per construct for females (n=77) and males (n=195)

		Value		Expectancy		Cost	
		Female	Male	Female	Male	Female	Male
Formative Feedback	Mean	3.10	2.90	3.41	3.17	2.20	2.24
	Std Dev	.54	.55	.44	.52	.68	.61
Real-World Applications	Mean	3.46	3.31	3.59	3.47	2.22	2.16
	Std Dev	.36	.41	.34	.42	.62	.61
Student-to-Student Discussion	Mean	3.18	3.06	3.21	3.06	2.13	2.14
	Std Dev	.57	.52	.58	.57	.62	.67

Although Table 5 suggests men and women responded in essentially equivalent manners, MANCOVAs revealed some significant differences when course size, years of teaching experience, and course level were controlled. The elements of value, expectancy, and cost were designated as dependent variables, with the covariates of teaching experience, class size, and course level applied. Gender had a significant effect on outcomes ($p < .05$) in four of nine categories after controlling for the effect of these variables (Table 6). 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), are considered small – implying real but difficult to detect effects.

Table 6. 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

Because the constructs of value and expectancy on VECTERS are comprised of items that can be further categorized, we drilled down deeper and conducted an analysis of those subcategories. The 11 value items were categorized as items indicating a strategy has value for students (8 items) or has value for the instructor (3 items). Similarly, expectation of success (i.e., expectancy) items could be categorized as expecting success due to students (5 items), due to instructor ability (2 items) and due to 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 7 summarizes those categories where significant differences were found.

Table 7. 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 app. - 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 some anticipated and unexpected results. Multiple studies that broadly examined faculty practices in higher education found that female faculty are more likely to utilize student-centered teaching practices.[18,19,20,21] However, the results of this study indicated few gender differences regarding how often student-centered strategies were used by engineering instructors. Previous studies examined the use of class time in regards to student-centered and content-oriented strategies, but provided limited information about gender based faculty dispositions towards student-centered teaching strategies. 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 future plans to use these strategies.

What was more revealing were the multiple significant gender differences when dispositions were analyzed (Tables 6 and 7). Women are significantly more confident regarding the value of both real-world applications and formative feedback; similarly, women expect success to emerge from the use of these strategies. However, women and men consider 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 simply imply that men have less optimistic attitudes, but also points toward the need for on-the-ground research wherein practices are observed.

The attitudinal results are consistent with previous research. 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 contributes to the understanding that there are gender-based differences between instructors. The more positive attitudes of female instructors may have 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 it is a trend.

The findings from this study, point to a need for similar research that focuses on gender differences among engineering faculty 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.

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 the genders. The exception was that 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.

The findings also compel a question regarding *why* dispositions about teaching are so different between male and female engineering faculty. Possible underlying reasons include differences in personal learning styles, 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 and men more often for research.

Further study is needed to better understand gender-based differences of teaching strategies, as well as the implications for both faculty members and students. Important questions to consider in future studies include the following: What are other gender-based differences among faculty? Are women more likely to be placed in teaching versus research roles? What is the impact 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? Are there differences in student performance based off of instructor gender?

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