Diverse Engineering Faculty's Perceptions and Practice of Active Learning at a Southwestern University Abstract

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Diverse Engineering Faculty's Perceptions and Practice of Active Learning at Texas A&M University

Abstract

This research paper studied faculty development aimed to improve the pedagogy used in existing and newly designed active learning spaces. Texas A&M University opened 32 new active learning spaces in a redesigned engineering building in fall 2018. In essence, these redesigned spaces embrace the idea of enabling active learning in every space by deliberate design of furniture, spacing and technology. To aid faculty in assimilating active learning pedagogies into their course(s) in both existing and redesigned spaces, a college-wide faculty development initiative was developed. Two studies explored engineering faculty's knowledge, perceptions and practice of active learning at Texas A&M. Study I surveyed the faculty development program participants, prior to attending the first workshop, about their knowledge, perceptions and practice of active learning. While around 130 faculty members were invited to respond to this survey, 81 (65%) completed it. Study II inquired about the enthusiasm of teaching for all faculty who were assigned to teach in the redesigned engineering building, as well as a sampling of faculty who were not assigned to teach in the redesigned space. Of the 375 invited survey participants, 92 (24.5%) fully responded. The data analyses from both surveys revealed that faculty members' knowledge, perceptions, and practice of active learning were limited and sometimes incorrect. However, faculty who participated in the college-wide faculty development initiative had greater enthusiasm about the newly redesigned spaces and ideas about how to effectively utilize the space for the benefit of student learning. Statistically significant differences were found showing women were more familiar with active learning, non-tenure track faculty knew of more active learning strategies, and faculty with more industry experience were more optimistic about the efficacy of teaching with active learning strategies. We hope to present this study with findings in a traditional lecture session with active strategies.

I. Introduction

Today's complex challenges facing society require innovative engineers that are equipped with a wide set of knowledge and skills, which they can integrate to create innovative solutions and processes. To address this need, significant research and work have been done to enhance engineering education. A traditional lecture course may be an effective pedagogical approach for efficiently disseminating a large body of content to a large number of students. However, these one-way exchanges from professor to student typically promote passive and superficial learning and have a negative impact on student motivation, confidence, and enthusiasm [1] - [3]. As a result, a traditional lecture approach can result in students not having the needed skills to succeed in an ever-changing, ever-advancing global market.

In contrast, *active learning* strategies promote student engagement and thinking about what they are learning and how it integrates into their existing knowledge base. While there are multiple definitions, Prince [4] provides a widely accepted and overarching definition: *active learning* is generally defined as any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing. A wide-variety of instructional strategies fall under the category of active learning, such as collaborative learning and project-based learning. Numerous studies have demonstrated the efficacy and positive benefits of active learning strategies in development of both core knowledge and skills [5] – [7]. This pedagogical approach also has positive impacts on student affect characteristics, such as confidence and motivation [8]. However, as with any pedagogical approach, the instructor's implementation has a tremendous impact on the efficacy of the students' learning and the classroom environment.

A. Theoretical Background

Numerous studies have demonstrated the efficacy of active learning to enhance mastery of content as well as persistence in fields of study. Specifically, Prince [4], Freeman et al. [5], and Watson and Froyd [2] studied the practice of active learning in engineering, where broad gains, better examination and concept mastery, and persistence were shown. In addition, Lamancusa et al. [9] showed that creating a 'Learning Factory', an environment focused on learning in an industry-like environment, enhanced learning and persistence for diverse students. Furthermore, Streveler et al. [1] showed active learning can enhance deeper conceptual understanding, and Vos and Graaff [8] showed that active learning enhances learner metacognition (i.e., recognition of their thought processes). While the literature leaves little doubt that active learning enhances student learning, nationwide, engineering faculty's adoption of this pedagogical approach by has been slow.

There has been limited work focused on engineering faculty's frequency and pace for the adoption of active learning strategies. In science, Pundak and Rozner [10] noted four factors that strongly influence faculty utilization of active learning strategies: (1) faculty readiness, (2) faculty awareness of a local model (e.g., based on topics, space, and organizational culture), (3) access to expertise in approach, and (4) faculty's creative design of problem solving. Therefore, we wanted to study our approach to faculty development in which we promote the use of active learning in both a newly redesigned engineering building meant to enhance this pedagogy, as well as advance the utilization in traditional teaching spaces.

B. Texas A&M University's Engineering Program Background

This study was conducted at Texas A&M University with slightly over 600 faculty members (by headcount not full-time equivalence) involved in delivering engineering courses to over 19,500 students majoring in multiple engineering fields, as well as engineering technology, computer science and industrial distribution. Within this faculty, 36.6% are professors, 19.6% are associate professors, 13.7% are assistant professors, and 29.9% are in non-tenure track positions. Of the engineering faculty, 17.4% are women, 25.6% Asian, 1.4% Black or African American, 7.4% Hispanic, 1 American Indian, and 8 unknowns. Of the tenured or tenure track faculty, 15.6% are women, 35.7% Asian American, 1.1% Black or African American, 7.9% Latino American, 1 American Indian, 8 unknowns. For those teaching but not in a tenure track position, 26.7% are women, 11,2% are Asian American, 2.7% are Black or African American, 8.6% are Latino American. Many of the engineering faculty have originally come from other countries, with 8.1% of the total faculty remaining on international visas. Of the total engineering faculty, based upon CV data, 16% have over five-years industry experience.

C. Faculty Development for Engineering Faculty

In order to offer a more modern learning environment, new active learning spaces were constructed in a redesigned engineering building on the Texas A&M University campus. Active learning spaces afford faculty new approaches to instruction. To aid faculty in assimilating active learning strategies into their course(s) in both existing and newly renovated learning spaces, a college-wide faculty development initiative was developed. The initiative included a workshop series and community of scholars' activities in the spring, summer, and fall of 2018 aimed to prepare and support faculty as they transition to teaching in a modern learning environment much different than that they are accustomed, as well as encourage faculty to adopt a more active approach to teaching in general. The initiative teaches faculty how to work in the newly designed active learning spaces and assists them in taking full advantage of active learning opportunities, with the ultimate goal being better student learning. The initiative brings an aspect of faculty development incorporating curriculum and instruction, as well as an opportunity to research both the faculty development offered and the influence of the new spaces on faculty motivation and teaching. Research in preparing and supporting faculty as they transition pedagogical paradigms into those that engage and cultivate students in an active learning environment is of current need and will grow as more active learning spaces are designed and built.

The faculty development program was a deliberate collaboration bringing together the expertise of three campus units - the College of Engineering, the Center for Teaching Excellence, and Instructional Technology Services. Titled the Active Learning in Engineering Program (ALEP), the researchers created a comprehensive faculty development program that consisted of five main components: (a) a learning management system online community, (b) a workshop series, (c) community of scholar's activities, (d) technology training, and (e) a practice teaching session. This research focuses on the online community, workshop series, and community of scholars' activities, with the workshop series being the main hub for content delivery. The content was delivered in a series of three workshops anchored in engineering education that brought in elements of today's student, how people learn, course design using an engineering design mindset, planning for all students, and an introduction to different types of active learning strategies. Also included in each workshop was deliberate time given for faculty to do both individual and group reflection and discussion of the content, how it applies to their course(s), and to begin developing an implementation plan to incorporate at least two small active learning ideas. Content delivered in the workshops was supplemented through community of scholars activities in which faculty were encouraged to either create their own community, join a researcher lead community, or both as a means to share ideas, debrief on how classroom implementation was going, and continue talks about teaching.

D. Study Purpose

We employed two studies (Study I and II) to explore engineering faculty's current knowledge, perceptions and practice of active learning for diagnostic purposes at Texas A&M University. Study I surveyed participants prior to them engaging in a faculty development initiative that introduced them to active learning. Information was gathered to explore any differences in their knowledge, perceptions and practice of active learning strategies by gender, tenure status (non-tenure, tenure track, and tenured), years of teaching, years of working in industry, and culture (undergraduate education in the USA vs. non-USA). At Texas A&M, non-tenure track faculty have varied titles, such as instructional professor, instructor, lecturer, or professor of practice.

Study II explored the enthusiasm of faculty assigned to teaching in the newly designed space to enhance active learning (e.g., the space/layout and technology in the classrooms), and how they intended or imagined these spaces could be used effectively. This study also included a smaller sampling of faculty who were assigned to existing teaching spaces instead of the newly redesigned spaces. No demographic data other than department, rank, and if they had been through the faculty development program was gathered.

Both Study I and II utilized mixed methods collection and analysis of both quantitative and qualitative data.

II. Methods

A. Participants

Study I. Prior to attending the first ALEP workshop in the spring, summer, and fall of 2018, Study I asked engineering faculty invited to participate in the program to respond to an online survey. While around 131 faculty members were invited to respond to the survey, 81 (65%) completed it. Table 1 shows the survey respondents' demographic characteristics. The majority of participants were male (74.1%) and almost half (49.4%) received their undergraduate education at institutions in other countries. Less than half of participants (48.1%) were non-tenure track faculty. Years of teaching experience ranged from 0 years (i.e., newly hired) to 60 years (N = 81, M = 9.18, SD = 10.62). Years of industry experience ranged from 0 years to 41 years (N = 81, M = 8.96, SD = 11.49).

Table 1. *Engineering Faculty Participants Demographic Characteristics*

Category	Subgroup	*n*	%
Gender	Female	21	25.9
	Male	60	74.1
Undergraduate Education	USA	41	50.6
	Non-USA	40	49.4
Track	Tenure	42	51.9
	Assistant Professor	20	24.7
	Associate Professor	12	14.8
	Professor	10	12.3
	Non-tenure	39	48.1
Major	First-year Engineering	15	18.6
	Aerospace Engineering	4	4.9
	Biological and Agricultural Engineering	4	4.9
	Biomedical Engineering	7	8.6
	Chemical Engineering	1	1.2
	Civil Engineering	23	28.4

	Computer Science/Computer/ Electrical Engineering	3	3.7
	Engineering Technology and Industrial Distribution	3	3.7
	Environmental/Ecological Engineering	2	2.5
	Industrial and Systems Engineering	6	7.4
	Material Science Engineering	1	1.2
	Mechanical Engineering	7	8.6
	Nuclear Engineering	1	1.2
	Petroleum Engineering	1	1.2
	Ocean Engineering	6	7.4
Total		81	100.0

Study II. Prior to teaching in fall 2018, 375 engineering faculty were invited to respond to a survey about their enthusiasm and intended use for the space/layout of the classrooms and technology in the rooms they were assigned to teach. The response rate was 24.5%, with 73 respondents from those assigned to teach in the new building (40% of total teaching in the building), and 19 respondents from those not assigned to teach in the new building (11% of those invited to participate in the survey). All departments had at least one faculty respond, with a disproportionately high representation from the study's lead author's home department. All faculty ranks were represented in the response in approximately their proportion within the total faculty in the College. Of the 73 respondents teaching in the newly redesigned building, 26 had been through the active learning faculty development program. Of the 19 respondents not teaching in the newly redesigned building, 8 had been through the active learning faculty development program .

B. Measures

Study I. An online survey was constructed to probe participant's knowledge, perceptions and practice of active learning. The survey consists of four sections: knowledge, perceptions, practice of active learning, and demographics. To explore their current knowledge, participants were asked to describe what active learning means in their words. To assess their perceptions of active learning, we identified existing scales in the literature [5] - [7], [11], [12], and finalized 40 items across six constructs: (a) general attitudes toward active learning, (b) familiarity and use of active learning, (c) active learning for students, (d) active learning outcome expectancy, (e) active learning support systems, and (f) interests in using active learning strategies in class (see Table 2 for the construct definitions along with an example item and internal consistency reliability evidence (Cronbach's α) of the Active Learning for Faculty Scale. A seven-point Likert scale (1 = "strongly disagree" to 7 = "strongly agree") was used for the scale. To better understand faculty's current practice of active learning, participants selected strategies they use in their class from a list of 21 active learning strategies, described other strategies used but not listed, identified their most frequently used strategy and explained why. The list of active learning strategies was adopted from Prince [4].

Table 2. *Constructs definitions and an example item on the Active Learning for Faculty Scale*

Perception	Definition (Example Item)	No. of Items	Cronbach's α
(a) General Attitudes toward Active Learning	Optimism that active learning will result in better student attitude toward course and better learning (e.g., Active learning is a useful tool.)	10	.857
(b) Familiarity and Use of Active Learning	Instructor has heard of or used active learning approaches prior to the workshop (e.g., I am familiar with the term "active learning".)	6	.784
(c) Active Learning for Students	Perceptions that the students will have a positive response about and to active learning (e.g., Students are willing to engage in active learning.)	9	.902
(d) Active Learning Outcome Expectancy	Student responses to assessment of their learning and to evaluating teaching will be positive when active learning is used (e.g., Student participation will increase from the use of active learning.)	5	.892
(e) Support for Active Learning	Organization supports skill development in active learning instruction and recognizes the effort positively (e.g., There are teaching support services to assist me using active learning.)	5	.810
(f) Interests in Using Active Learning Strategies in Class	Instructor is interested in various aspects or possible improved learning by using active learning. (e.g., I am interested in engaging students using active learning strategies.)	5	.940
Total		40	.947

Study II. The second survey was more concise and intentionally asked fewer questions than the Study I survey. The second survey utilized five-point Likert scale responses for:

- How enthused are you about teaching in the classroom you are assigned?
- How enthused are you about the technology in your assigned classroom?

In addition, the Study II survey queried responses to how the faculty thought they would use the classroom layout or technology to enhance student learning.

C. Data Analysis

First, descriptive statistical analyses were applied for frequency data, such as the counting of common themes that appeared in the coded Survey I open-response questions – asking participants to describe in their own words what active learning means, activities used in class and the most frequently used activity. Second, inferential statistical analyses, including correlations and independent samples *t*-tests, were applied for continuous data, such as industry experience in years, teaching experience in years, the number of active learning strategies used, and scores on the Likert-type response data. We also conducted subgroup analyses by sex, undergraduate education countries (USA vs. non-USA), and tenure track status (tenure vs. non-tenure), with reported effect sizes, such as Cohen's *d* [13].

For open-ended responses, an inductive analysis and a creative synthesis strategy were employed to analyze the responses [14]. First, the researchers independently identified the themes that emerged in the data and then independently coded the data based on their identified themes. Second, they held occasional meetings to reach a consensus on their independently identified themes. Third, the researchers coded the data independently again based on the consensus themes and then compared, discussed and recoded until they reached a consensus on all of the coding. Finally, the researchers labeled and described the themes and calculated the frequency of each theme as it appeared in faculty's raw responses. The frequency data were then converted to the percentage of faculty who responded on each theme.

III. Results

A. Study I: Correlations

The correlation matrix shown in Table 3 reveals several significant associations between variables of interest. Female faculty tended to perceive more familiarity and use of active learning than male faculty. Faculty who received an undergraduate education in the USA tended to have more industry experience than the faculty who received an undergraduate education in the non-USA. Tenure-track faculty tended to have less experience in industry and used a fewer number of active learning strategies than non-tenure track faculty, who also tended to have more industry experience.

Table 3. *Correlation Matrix between Demographic Characteristics, Perceptions and Practice*

Variable	1	2	3	4	5	6	7	8	9
Sex (Male = 0, Female =1)	-0.161	-0.063	-0.005	0.183	0.247*	0.197	0.112	-0.043	0.184
Undergraduate Education (non-USA = 0, USA = 1)	0.251*	0.202	0.063	0.072	0.145	0.150	0.156	0.126	0.179
Tenure (non-Tenure = 0, Tenure = 1)	-0.293*	-0.001	-0.259*	-0.204	-0.066	-0.150	-0.137	-0.080	-0.134
1. Industry experience in years	1	-0.122	0.176	0.154	0.094	0.194	0.253*	0.187	0.125
2. Teaching experience in years		1	-0.177	-0.237*	-0.188	-0.224*	-0.143	-0.210	0.074
3. Number of active learning strategies			1	0.433*	0.379*	0.363*	0.435*	0.228*	0.259*
4. General attitudes toward active learning				1	0.520**	0.630*	0.612*	0.310*	0.521*
5. Familiarity and use of active learning					1	0.595*	0.502*	0.412*	0.385*
6. Active learning for students						1	0.703*	0.460*	0.564*
7. Active learning outcome expectancy							1	0.465*	0.592*
8. Support for active learning								1	0.264*
9. Interests in using active learning strategies in class									1

N	81	81	80	81	81	81	81	81	80
M	9.17	9.15	6.08	5.39	4.57	5.10	5.16	4.86	6.10
SD	11.57	10.56	3.20	0.90	1.12	0.92	1.01	1.02	0.94

Note. $^{*}p < .05$

Faculty's industry experience in years showed a positive correlation with perception of active learning outcome expectancy, but faculty's teaching experience in years showed a negative correlation with perceptions of general attitudes toward active learning and active learning for students. The correlations among the six constructs are all positive with small to moderate correlation coefficients [13].

B. Study I: Prior Knowledge of Active Learning

Faculty responses to the open-ended question asking them to describe active learning in their own words revealed several common themes, as defined in Table 4 along with frequencies of those common themes. Nine out of 81 respondents (11.1%) presented misconceptions on active learning. Two common misconceptions, held by several (5) responders, were that: (a) active learning was only when you stop teaching poorly and (b) active learning only occurred with the use of computing technology.

Table 4. *Common Themes about the Definition of Active Learning*

Theme	Definition	*n*	%
Student Engagement	Simply stated the faculty would get students more engaged without stating how.	67	82.7
Real-life Experiences	In course, but not always in classroom, students would be given more complex realistic problems to solve.	7	8.6
Deeper/Lifelong Learning	No activity specified but expecting that students will learn more deeply or develop some self-initiating strategies in learning.	10	12.3
Use of Active Learning Strategies		22	27.2
Hands-on	Any active problem solving	11	13.6
Group Activities	Teams or informal grouping	10	12.3
Flipping	Lecture outside of class time so that class time was spent on problems.	3	3.7
Sandwich	In between short lectures have students active in answering a question or solving a problem	2	2.5
Total		81	100.0

C. Study I: Perceptions of Active Learning

Figure 1 presents average item scores indicated for the six constructs: (a) General Attitudes toward Active Learning, (b) Familiarity and Use of Active Learning, (c) Active Learning for

Students, (d) Active Learning Outcome Expectancy, (e) Active Learning Support Systems and (f) Interests in Using Active Learning Strategies in Class. Among them, while faculty showed the highest scores on (f) Interests in Using Active Learning Strategies in Class, they presented relatively low scores on (b) Familiarity and Use of Active Learning and (e) Active Learning Support Systems.

Subgroup analyses revealed that statistically significant gender differences only existed in (b) Familiarity and Use of Active Learning with female faculty (n = 21, M = 5.03, SD = 1.04) who scored higher than male faculty (n = 60, M = 4.41, SD = 1.11) with $t(79) = 2.3$, $p = .026$, Cohens' d = 0.57, which is a moderate effect size. There were no significant differences in the perceptions by the undergraduate education countries (US vs. non-US) nor tenure-track status (Non-tenure vs. tenure). When faculty were grouped by their years of industry experience (five years and less vs. more than five years), faculty with more than five years of industry experiences (n = 34, M = 5.46, SD = 0.99) scored significantly higher than faculty with industry experience of five years or less (n = 47, M = 4.95, SD = 0.97) on (d) Active Learning Outcome Expectancy with $t(79) = 2.3$, $p = .024$, Cohens' d = 0.52, which is a moderate effect size.

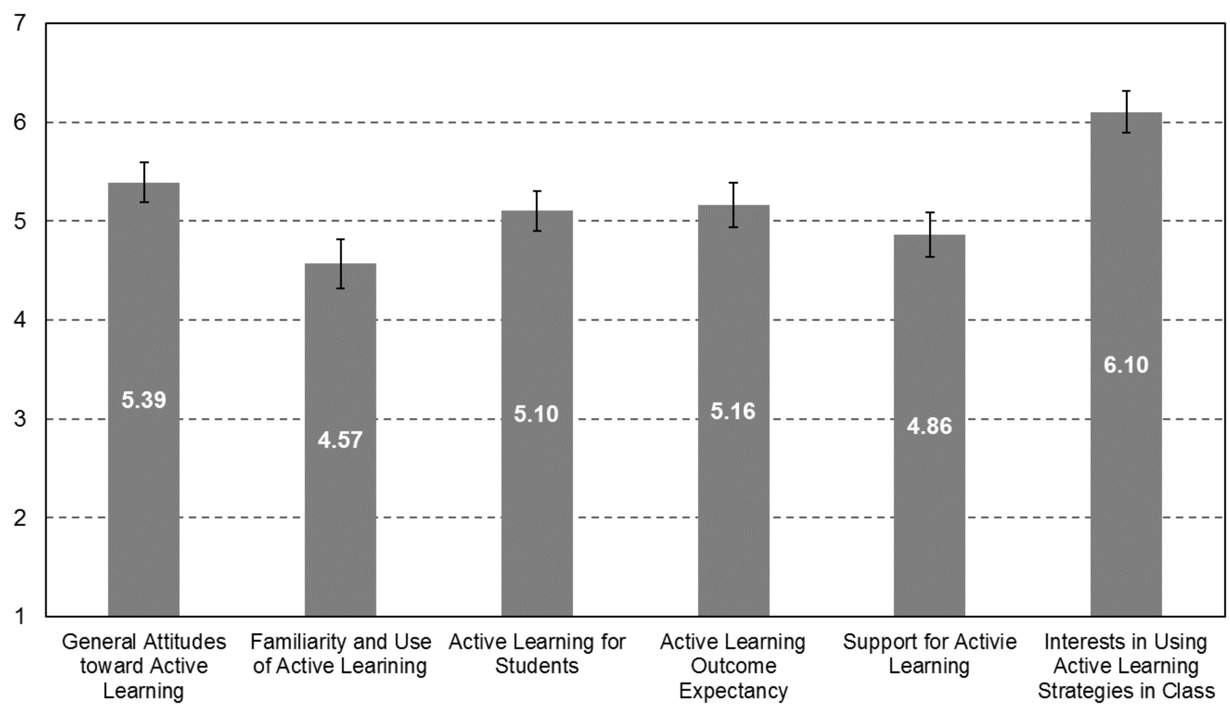

Figure 1. *Engineering faculty perceptions of active learning (n = 80)*

D. Study I: Practice

Types of Active Learning Strategies. Figure 2 presents use of active learning strategies as revealed by engineering faculty (n = 80) from a provided list of 21 strategies. On average, each respondent indicated having used six strategies (M = 5.96, SD = 3.15). The most popular strategy was problem/project-based learning (67.5), followed by question and answer (57.5%), application activity (48.8%), and small group discussion (48.8%). There were an additional five strategies added by respondents (e.g., video demonstration, motivational lectures, and directed study/homework) not on the list; they were not counted as active learning strategies.

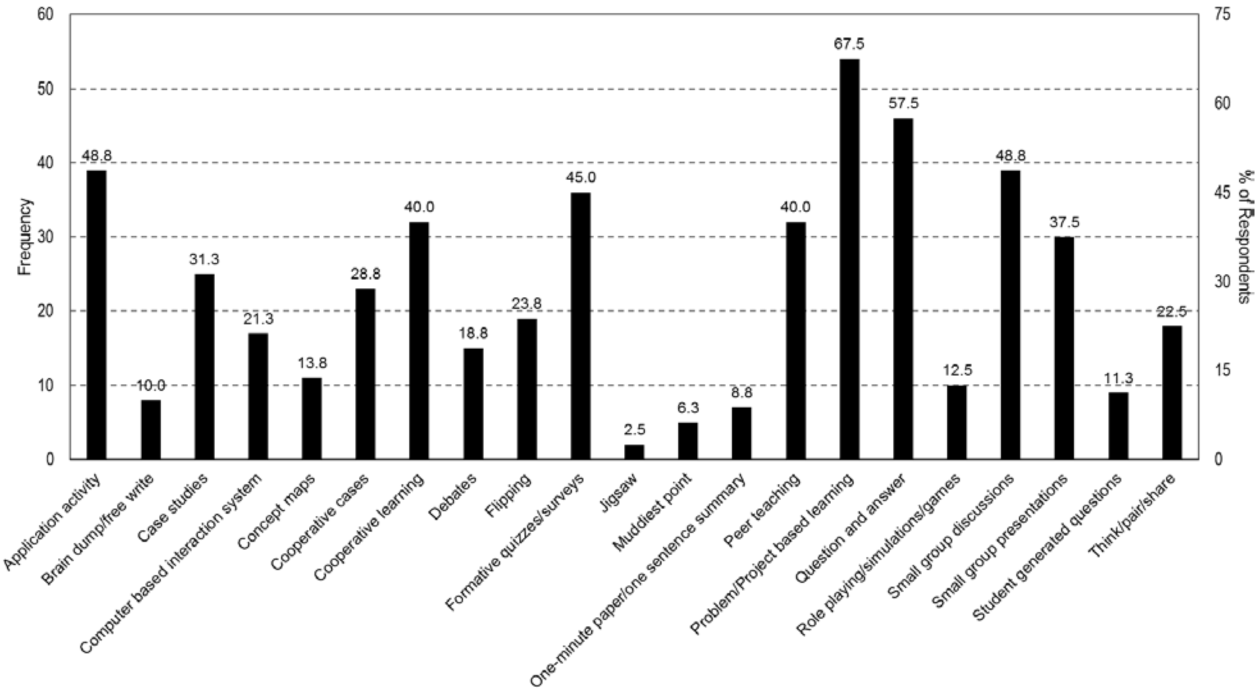

Figure 2. *Active learning strategies used by engineering faculty (n = 80)*

The Most Frequently Used Active Learning Strategy. Figure 3 presents the popularity among the engineering respondents for each of the 21 active learning strategies listed in the survey. When asked to pick their most frequently used, 73 respondents mentioned 17 out of 21 strategies. More than 20% of respondents selected multiple strategies, some even up to five. In those cases, the weight of the frequency was distributed across the selected strategies (e.g., when a participant selected four activities, the frequency of 0.25 was given to each activity). Problem/project-based learning (13.4%), question and answer (9.3%), and small group presentations (7.7%) were the top three active strategies faculty use the most in class. Four activities, brain dump/free write, cooperative cases, jigsaw, and student generated questions were the least selected active learning strategies.

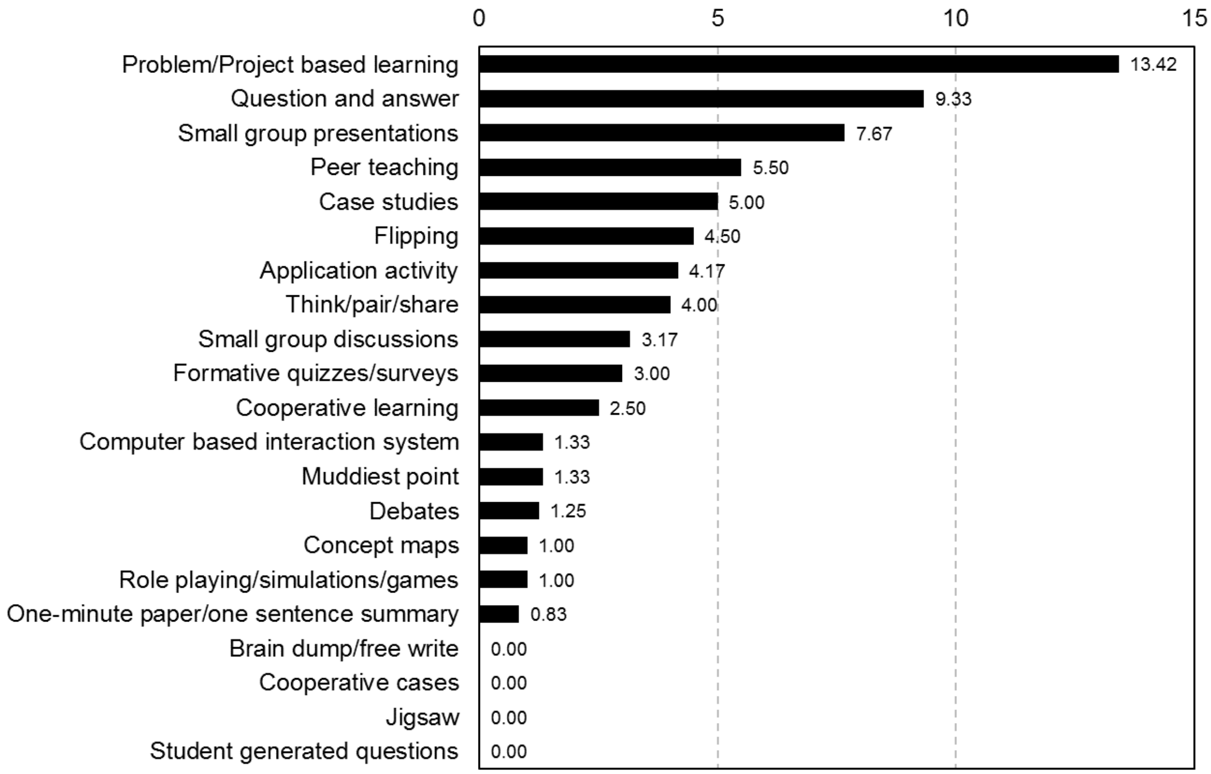

Figure 3. *The most frequently used activity learning strategies (n = 73)*

Number of Active Learning Strategies Using. While there were no significant differences in faculty's number of active learning strategies by sex and undergraduate education countries, there was a significant difference by tenure track status with $t(79) = 2.4$, $p = .020$, Cohens' $d = 0.53$, which is a moderate effect size. Non-tenure track faculty ($n = 41$, $M = 6.88$, $SD = 3.30$) used significantly more active learning strategies than tenure track faculty ($n = 39$, $M = 5.23$, $SD = 2.90$).

E. Study II: Enthusiasm of Teaching

Table 5 presents average scores from Study II's five-point Likert scale responses on enthusiasm of teaching in the assigned classroom. The faculty who participated in the faculty development program either were already enthused about utilizing teaching spaces to enhance their teaching, or more probable to, because not all volunteered to participate in the program. The faculty development program participants were enthused about utilizing space to enhance teaching, regardless of whether they were in the new spaces or not. In looking at faculty members enthusiasm for the space they were assigned, we found a positive correlation when assigned to the newly redesigned building ($r = 0.099$) and an even more positive correlation when they had been through the faculty development program ($r = 0.292$). Both correlations were statistically significant ($p < 0.05$). The strength of the correlation and the fact that the means were significantly higher for faculty who had attended the faculty development program, whether they were assigned to a newly redesigned space or not, indicates that the program had significant impact, in spite of excitement about the newly redesigned space.

Table 5. *Enthusiasm of Teaching in the Assigned Classroom*

Condition	Physical Space/Layout		Technology	
Redesigned Building	Attended faculty develop program	Did not attend faculty development program	Attended faculty development program	Did not attend faculty development program
Not Assigned				
n	8	11	8	11
M	4.38	3.09	4.63	3.72
SD	0.69	1.31	0.70	1.05
Assigned				
n	21	47	21	47
M	4.33	3.68	4.38	3.60
SD	0.78	1.19	0.79	1.20

F. Study II: Use of the Classroom Space or Technology

Table 6 presents the themes with frequency from Study II's survey open-response question asking how faculty in the redesigned classrooms planned to use the space to enhance student learning. It is important to note that the faculty who participated in the faculty development program highlighted more than one plan, and typically with more specificity than those who had not participated in the faculty development program. It is also significant that no faculty who participated in the faculty development program stated they would use no active learning strategies, and only one of the faculty who had participated in the faculty development program found the rooms distracting. Finally, only faculty who had not participated in the faculty development program answered the question about room utilization as if it was only about using the technology in the class. Alternatively, only faculty who had participated in the faculty development program went into detail about how they would engage the students in more brainstorming and creative activities.

Table 6. *Common Themes for Faculty Plans on Using the New Space to Enhance Student Learning*

Theme	Definition	*n*	%
Teams/group discussions	Most envisioned actual team or group assignments, but some envisioned targeted dialogues	49	67
Less Lecture	Many stated nothing they would do, just that they would lecture less	30	41
Brainstorming & Creativity	Descriptions of more realistic problem analysis and especially design	10	14
Do nothing	No plans to use active learning strategies, doing nothing different than traditional lecture with individual dialogue occasionally	9	12
Rooms are distracting	No discussion of what could be enhanced, just that the rooms were not good for teaching	15	21

IV. Discussion

The creation of a newly redesigned engineering building with 32 active learning spaces necessitated the development and offering of a structured faculty development program providing upskilling opportunities that introduced and enhanced the faculty use of active learning techniques in these spaces. This in turn resulted in the design of the mentioned studies on faculty's knowledge, perceptions and practice of active learning. Researchers set out to understand the a priori influences that affect the faculty mindset and secondly inform the development of a faculty development program focused on helping transform faculty perceptions and introduce them to the research, strategies and benefits of active learning.

We found the results showing that before attending any faculty development, female faculty were more familiar with active learning techniques than male faculty. There was no significant difference in familiarity between faculty who had foreign vs. U.S. undergraduate degrees. The knowledge of techniques could be an indicator of how faculty were selected to attend the faculty development program (department nominations vs self-nominations). Since we did not have a variable on motivation, we could not differentiate on factors influencing program attendance.

A. Study I: Knowledge, Perceptions, and Practice of Active Learning

Study I's data indicates engineering faculty participating in the faculty development program demonstrated an overall positive attitude toward active learning across the six constructs. The data also showed there were misconceptions held by some participants about what active learning is, as borne out by the open-ended question that asked faculty to describe active learning in their own words. The same attitudinal survey administered after the program showed a low return rate, thus not enabling statistical analysis on any attitudinal change resulting from participation in the faculty development program. However, it is interesting to note that data from Study II indicate that faculty who have gone through the faculty development program were able to identify and describe more active learning strategies than faculty who had not been through the program. This could in essence serve as a proxy for program efficacy.

Mapping faculty experience to the data, specifically to expected learning outcomes, showed that faculty who were non-tenure track who tended to have multiple years of industry experience tended to have higher expectancy than tenure/tenure track faculty. This discrepancy could be possibly be tied to the fact that faculty with longer experiences possibly required more change in their teaching, thus leading to a mildly pessimistic view initially vs. non-tenured faculty with industry experience gravitate towards the idea that active learning is about working on real problems, leading to a more positive view.

B. Study II: Enthusiasm of Teaching and Use of Classroom Space

The effects of the teaching space itself was another interesting result. Study II revealed that while the faculty who attended the faculty development program showed a marked enthusiasm for the use of the space and technology, the data also showed that just being in the newly designed teaching space itself was enough to raise the enthusiasm level of faculty who had not attended the program. This data point is very useful to help inform any future design work that is undertaken at Texas A&M or elsewhere. One possible strategy to adopt in new learning space design is to have strong faculty presence in co-creation opportunities, which may help adoption rates. This also informs the need for the development of a shorter upskilling faculty development program for faculty while they are getting accustomed to teaching in the newly designed learning spaces.

C. Limitations of the Study and Suggestions for Future Research

The faculty development program's target participants are Texas A&M engineering instructors. This study was quasi-experimental, not a randomized controlled trial, and consisted of only those faculty who self-selected to participate or were required to participate. In future program iterations, the researchers will continue to try to broaden the participant population. Also, the scales used in both Survey I and Survey II have not yet been validated. Both were created based on existing scales/surveys in the literature for use with the faculty development program and have only been administered to program participants at Texas A&M, whose count has not reached sufficient numbers for scale validation. Thus, the results of the study are limited in terms of their generalizability beyond the study's sample characteristics. Future research conducted would look to also broaden survey distribution to other institutions as well.

Other study limitations include confounding factors pertaining to the types of courses faculty teach, engineering science/conceptual courses versus practical courses. In addition, faculty come with diverse amounts and experiences with previous faculty development and exposure to active learning pedagogies. Both of these also factor into the study's generalizability.

We plan to administer Study II's survey to all faculty participants who attend the faculty development program again later this year, as well as faculty who did not attend the workshop but were assigned to teach in the newly redesigned building. The hope is that being in the newly redesigned active learning spaces and currently using active learning strategies will help mature their ideas, providing useful data on the faculty development program's efficacy.

D. Conclusion

We studied the efficacy of a faculty development program, consisting of workshops and community of scholars activities, which was created because of the desire to ensure instructors assigned to teach in a redesigned engineering building opted to make every teaching space particularly adapted for an active learning class. This meant a shift in pedagogical practice, with much less regard for lecturing as a significant part of the courses. It was clear that many faculty were not aware the redesign was being done with this change in teaching paradigm in mind. Not because instructors had not had opportunities to see what was being considered, but rather that the building redesign did not rise to their significant concern given all the other demands on their time. However, their concerns heightened as the prospective building, and their own assignments to teach in the building, became more imminent. We took the opportunity to invite faculty to learn about and hone their pedagogical skills in active learning, no matter where they were assigned to teach. Our data shows that the faculty development program did:

- Enhance the perception faculty had about the efficacy for students when active learning is used;

- Increase the number of approaches to active learning faculty understand and plan to implement; and
- Increased the enthusiasm faculty members assigned to the newly redesigned space had for the spaces.

We understand that some faculty, particularly women, non-tenure track faculty, and faculty with more than five years of industry experience, came to the program with more knowledge of and positive attitudes about the prospects of active learning approaches. We do not have data on who in the initiative chose voluntarily, and who were directed to attend. Therefore, a significant factor not discerned by our study may indicate that much of the gains of the initiative can be attributed to the faculty members' predisposition to active learning rather than the efficacy of our initiative in faculty development. However, we believe the data indicates the initiative did create a better reaction by faculty to the new spaces and more ideas about how the faculty would use the space. We did not choose to do another study on what has been shown previously by many concerning the positive outcomes that can be attained by using active learning. Instead, we focused on the fact that these positive outcomes can only be attained in the faculty are enthused and skilled in whatever approach they take to teaching.

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