Impact of Teaching Style on Student Learning and Satisfaction in Statics Courses

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Abstract

The purpose of this study was to explore relationships between teaching methods and students' learning and satisfaction in statics courses. This study explored the teaching methods that were used in sophomore-level statics courses taught by three different instructors. The teaching methods ranged from fairly standard lecture with numerous example problems worked during class to flipped class that was highly interactive. Faculty interviews and student focus groups provided insight into the course from both perspectives. Students took a statics concept inventory to gauge topic-based knowledge as well as a separate self-assessment of their learning gains. Results show no clear link between instructional methods and student understanding of statics concepts but do show a student preference for the more active, student-centered classrooms. Faculty member interviews showed a trend toward teaching based on personal philosophy of how their efforts will affect student learning. These preliminary results serve as initial insight into faculty and student perspectives of the engineering science courses that are typical of the sophomore year in engineering.

Introduction

The purpose of this study is to understand the impact of the application of innovative teaching methods in statics courses on student learning and student attitudes. We evaluate the quality and depth to which faculty apply diverse teaching strategies for statics courses. It is our goal to increase the adoption of research-based instructional strategies in statics courses, which will increase the success of students in earning engineering degrees. We plan to motivate this change by providing information on the effectiveness of innovative teaching methods in statics courses, data on effective methods and environments that facilitate faculty adopting these methods and applying them effectively, and by providing data on the importance of statics instruction to students' satisfaction and knowledge of statics. This information can then be leveraged to encourage instructor training, communities of practice around research-based instructional strategies in statics courses, and administrative level support of these activities.

Background

Evidence-based methods are becoming more widely adopted in first year courses. For example, a majority of engineering programs have hands-on and/or design-based courses in the first year to get students excited about engineering¹. But data shows that student attrition is high during the third semester, or first semester sophomore year² where there is less widespread adoption of evidence-based teaching. This attrition could be due to a combination of students' dissatisfaction, as well as poor performance that presents a challenge to continuing. For example, Rais-Rohani et al.³ report that in some statics classes, as many as 35 percent of students earn a D or an F. These grades are typically not high enough for the student to move on to subsequent classes and may dramatically alter a student's plans for earning an engineering degree in a certain period of time.

Therefore, targeting key courses in the sophomore year that serve as a foundation for further coursework in the discipline may be particularly effective in helping students.

While evidence shows that implementing more active teaching and learning strategies are effective in improving student engagement and learning⁴, there is often a disconnect between acknowledging the benefits of active learning strategies and actually implementing them in the classroom. For example, in a study of engineering department chairs, the awareness of educational innovations was 82 percent compared to only 47 percent adoption⁵. There are a number of barriers to implementing these techniques in an effective manner⁶. Hazen et al.⁷ found that logistical issues and cultural differences are barriers to implementation, while course management support and resources can facilitate the use of educational innovations.

Beyond the goal of improved student learning, improved teaching methods may have important implications for student retention. For example, the *Talking About Leaving* study showed that the main factor that influenced students to leave science, mathematics, and engineering fields of study was pedagogical – the mode of assessment and the design of curriculum were not adequately supporting students in learning⁸. A follow-up study is underway to learn why there has been minimal improvement in the retention of students in these fields, despite efforts for instructional improvement⁹. Retention improvements are consistent with the goals of the Engage to Excel report, which strategizes how to produce 1 million additional graduates with degrees in STEM¹⁰.

It is also important to note that while instructors may try to adopt evidence-based teaching innovations, the quality with which they implement the innovation may vary significantly and therefore may not result in improved student learning outcomes. A recent study found that active-learning instruction did not improve student learning of the concept of natural selection when implemented by typical college biology instructors¹¹. Fifty-five instructors were selected at random from the largest public universities in each state and top ranked programs, resulting in performance data from ~8000 students. The courses were separated into categories representing the extent of active learning: almost never (12%), once per week (27%), once per class (24%), or more than once per class (36%). The data hints at the varying quality of implementation of instructional innovations.

It is uncertain if careful classroom observation methods might be able to distinguish the quantity versus the quality of teaching methods. Ebert-May et al.¹² used the RTOP method¹³, which has been previously shown to correlate with student achievement¹⁴. Also, simply incorporating a teaching method does not guarantee student buy-in. Haron and Shaharoun¹⁵ noted that only 10 percent of the students were participating during the in-class problem solving activities while about 90 percent were passive. Therefore, it is important for the instructor to facilitate effective interactions during active learning integration.

Cutler¹⁶ studied the use of a variety of Research-Based Instructional Strategies (RBIS) in the statics classes at a variety of Virginia universities. There were generally a high percentage of the instructors that responded positively to at least some use of various active learning methods. For example, only 9 percent said they never had students discuss problems in pairs or groups, and only 18 percent never had students work on problems sets or projects in pairs or small groups.

There are some important limitations of this work. First, it is unclear the extent to which instructor self-reporting is accurate (as noted by the author) or the extent to which the respondents were representative of all instructors. Responses might be more likely from faculty actively engaged in trying to teach statics most effectively. The quality of implementation of the various methods varies widely. As shown in a study of peer instruction using clickers, even instructors with the same cultural and structural constraints show significant observable variation in their use of the technology¹⁷.

<i>conceptual</i>	<i>think-pair</i>	<i>real world</i>	<i>hands-on</i>	<i>labs</i>	<i>problem</i>	<i>project based</i>	<i>service</i>
<i>clicker questions</i>	<i>-share</i>	<i>examples</i>	<i>manipulatives</i>		<i>based learning</i>	<i>learning</i>	<i>learning</i>

Figure 1. Various learner-centered teaching methods (simpler at left to more complex at right)

Many evidence-based methods do not yet appear to be widely applied in statics courses, and one reason for the slow change may be that instructors are reluctant to adopt new methods without data that they have not been successful in their particular course across a wide variety of institutions¹⁶. However, there are many examples in the literature of the application of student-centered teaching methods in statics courses. But it is unclear if new teaching methods are sustained after the innovation is initially tried and published. Many courses also implemented multiple changes that combined a variety of innovative methods, so the impacts of particular innovations are unclear. Because the goal of this study is to understand and encourage more widespread use of evidence-based teaching methods, the simpler learner-centered teaching methods shown in Figure 1 will be the focus. This decision was based on the fact that instructors new to learner-centered methods are more likely to first implement the simpler techniques before moving on to those that are more complex.

Research Questions and Methods

For this study, the goal is to explore why faculty teach the way they do and how various methods of instruction affect student performance and satisfaction. The research questions are as follows:

- 1) How do the types and quality of teaching methods used for statics impact students' (a) knowledge of statics; (b) satisfaction with the learning environment

Types of teaching methods were evaluated by classroom observations (in tandem with answering research question 2 below). Item (a) was evaluated via comparative course grades in statics, and pre/post performance on a concept inventory. Students' satisfaction (b) was evaluated using and focus groups with students, the Student Assessment of Learning Gains (SALG) online survey, and end of semester evaluations.

- 2) What do statics faculty report were: (a) their background in and motivations for adopting innovative teaching methods; (b) their utilization of professional development opportunities to learn these methods; and (c) departmental or institutional support for using these innovations.

This research question was evaluated using interviews with faculty. Information on departmental and institutional support was gathered from the faculty interview and questions were meant to determine what factors positively influenced the use of an instructor's teaching methods.

Data was gathered from three different statics instructors, two at a major state research university (MRU) and one from a nearby urban, regional state university (URU). This represents statics courses for both civil and mechanical engineering students. In total, six statics sections were studied, for a total of three faculty and 174 students participating.

The research used a mixed methods approach, combining quantitative and qualitative methods to gather data. To gain insight into student statics knowledge, all students took a select set of questions of the Concept Assessment Tool for Statics (CATS)¹⁸. A modified version of the Concept Assessment Tool for Statics (CATS) was administered to MRU1 and MRU2 classes that included 4 of the possible 27 questions. The quizzes were administered approximately three-quarters of the way through the semester, after each of the topics included in the quiz was covered in class. Each multiple-choice question represented a concept from one of four categories: free body diagrams, static equivalence, loads at connections, and equilibrium. Students in the URU classes took the full 27-question concept inventory in an online format both as pre- and post-tests during the first and final weeks of classes, respectively. Their scores for the same four questions were separated and scored to provide equivalent comparison to the MRU classes. For each of the individual classes, the scores on the CATS survey were not included as part of the students final course grade.

To explore student satisfaction with the course, MRU2 and URU students submitted a survey about their impressions of their learning, the Student Assessment of Learning Gains (SALG)¹⁹. The SALG is an online survey that focuses on the “degree to which a course has enabled student learning.” The survey also asks questions to students to determine what specific aspects of the course students felt were most impactful to their learning. Students from MRU2 and all URU classes were given the opportunity to take the SALG as extra credit for the class.

One class session from each instructor was observed using the Reformed Teaching Observation Protocol (RTOP)^{20,13}. RTOP gauges to what extent an instructor is “reformed” based on three factors: (1) Lesson Design and Implementation, (2) Content (propositional knowledge and procedural knowledge), (3) Classroom culture (communicative interactions and student/teacher relationships). Each class was observed once and a RTOP (0-100) score was determined with a higher score indicating a higher degree of reformation. To ensure accurate RTOP scoring, the two raters practiced rating three classes using the RTOP training videos. Each rater watched the videos and rated them using the RTOP rubric. Then raters watched the calibration videos and compared their answers. Both raters observed MRU1 and MRU2, comparing answers and deciding upon one final value for each item. The classroom at URU was observed by a single rater.

Additional quantitative data analyzed by researchers included the student evaluations for each course and the grades assigned by instructors to the students. Table 1 summarizes the numbers of classes and students studied as well as the data acquisition methods utilized to gather data.

Table 1. Summary of Research Methods

Attribute	MRU1	MRU2	URU
Number of class sections	1	1	4
Number of students	43	50	41, 28, 19, 21

Concept Inventory (CATS)	✓	✓	✓
Student Assessment (SALG)	✓		✓ (3 of 4)
Faculty interview	✓	✓	✓
Classroom observation	✓	✓	✓
Focus groups	✓		
Grades	✓	✓	✓
Student course evaluations	✓	✓	✓

Qualitative research methods included faculty interviews and student focus groups. Faculty interviews for MRU1 and MRU2 instructors were performed in person by the researcher, audio recorded, and transcribed. The instructor for the URU sections wrote answers to each of the interview questions. The interview protocol focused on how the faculty member described his/her own teaching, his/her motivations for the teaching methods used, and past experiences that helped the instructor to make these decisions. Student focus groups were performed in the MRU1 class. Two focus groups were held concurrently by the researchers during class time and consisted of questions related to student perceptions of the class. The focus groups were made up of 6-8 students with majors in civil, environmental, or architectural engineering. The focus groups were audio recorded and transcribed.

Results and Discussion

The results presented in this section focus on (a) faculty member instructional methods and attitude towards them, (b) student knowledge of statics, and (c) student satisfaction with the course.

Faculty methods and attitudes

Three classroom observations, one of each instructor, resulted in a measure of teaching style according to the RTOP. Instructor scores were 28, 51, and 74 for the MRU1, URU, and MRU2 instructors, respectively. Interpretation of the RTOP scores and a description of each teaching style is provided for each instructor below.

Instructor interviews showed a correlation between instructor attitudes and the methods they implemented when teaching the course. The MRU2 instructor, who received a 74/100 on the RTOP scale, was the most reformed instructor in the study. He is a full-time instructor in an engineering department at MRU, not on the tenure track. His flipped classroom methods focused on concept-based clicker questions that students worked on in groups of 4-5 seated at each table – known as collaborative learning.²¹ Students received a worksheet that helped to guide their problem solving during class time. Also, he implemented a concise pre-lecture reading and set of questions to engage students with the material before coming to class. Very little time was spent on doing detailed computations in class; instead, he focused on the broader concepts. He describes his transition from running his class with more time spent on lecture and working problems in front of the class to a workshop model where there is minimal lecture and a focus on having the students work on problems on their own or in groups:

“When I did my first workshop, the whole class erupted, there was this energy, they were actively thinking about things. Now this is a much better use of their time than me droning on in front of the class.”

The MRU2 instructor describes learning about the workshop model from a specific colleague in his department initially and then following up by becoming familiar with the literature on active learning and pursuing additional professional development seminars offered at his university.

The MRU1 instructor, who received a 28/100 score on the RTOP scale, was the least reformed instructor in the study. He is a tenure-track assistant professor in his first semester in an engineering department at MRU. He has previous teaching experience in statics as a graduate student and post-doctoral research fellow. His classroom methods focused on lecture of topics and working through problems at the front of the class. The classroom was generally instructor-led with few questions posed to the students in attendance. Detailed solutions were worked through in class, including computation of answers. Also, students reported that copious notes were posted online on the course website, for students to use as reference or for practice outside of class. In his interview, this instructor focused on the idea that a large percentage of students were not likely to attend class or to be engaged if they did attend class. He believed that students only wanted to focus on learning what they would need to know for the exam. When asked whether he would plan to make any changes to his teaching method in the future, he declared there was no need, that he would not see a major benefit in student outcomes if he were to use different teaching methods.

The URU instructor, who received a 51/100 score on the RTOP scale, exhibited attitudes that fell somewhere in between the perceptions of the other two instructors. Fittingly, her RTOP score falls exactly between the other two. She is a part-time adjunct instructor only teaching statics at URU. The four sections of statics that she taught during the 2013-2014 school year were her first as the main instructor for a course. In her first semester, her course consisted of a lecture of concepts and working through problems in front of the class. For the second and third semester, the focus evolved towards having a shorter lecture time followed by more group work and problem solving among students during class time while pointing out conceptual ideas in a given problem or solution. Detailed calculations were worked through in class in all three semesters. She cited that she evolved to incorporate more active learning as she became more experienced at teaching:

“I realized that I don’t really like to be the only presenter in front of a group. I’d much rather work with students in smaller groups and help them one on one or one on two. I thought back to when I was an undergraduate and how much I didn’t like sitting through long boring lectures. I figure, if all this evidence says that lectures are the least effective form of instruction, I would try to minimize it.”

She reports reflecting in her own experiences as an undergraduate and her preference for active learning techniques. She also notes that she would like to do more but has not had any formal training:

“Ultimately, I do the best I can but feel that I don’t have a lot of formal training. I’d like to get it, but haven’t found the time, or taken the time, to do it ... I have taken a lot of what I observed as a student and focused on things that I liked and didn’t like. I have aspirations of using more research to help develop my teaching in the future.”

The faculty member who scored the highest on the RTOP also had the most formal training in effectively implementing active learning in the classroom. He is also the one faculty member in this study who is a full-time instructor, not on the tenure track.

Student knowledge of statics

The average student performance on the CATS questions are shown in Table 2. In all cases, the average class performance results were fairly poor, ranging from 19 to 38 percent. Scores for individual students on the CATS assessment ranged from zero to four correct (the maximum possible), with a median of one out of four questions correct for all students who took the assessment. Researchers ran two-tailed t-tests on the CATS assessment data from each section to determine whether different teaching styles resulted in different outcomes in performance. Results show no significant CATS assessment score difference between the classes of the most reformed instructor (MRU2, RTOP score 74) and the least reformed instructor (MRU1, RTOP score 28). This result does not align with the literature comparing collaborative learning to a lecture-based format. Rais-Rohani et al.³ report that implementing an emporium model (a form of a flipped classroom that implements collaboration and problem solving in class) showed promise in promoting stronger performance among students. Prince²¹ reports that, of meta-studies completed for the last 90 years, all indicated that collaborative learning resulted in positive learning outcomes compared to individual work. In the case of this study, the extremely small sample size and abbreviated CATS assessment is likely to have affected these results.

Significant differences ($p\text{-value} < 0.05$) did exist for the average CATS assessment score from the two statics sections at MRU and two lowest scoring sections at URU. These two URU sections consisted of students taking the statics class off cycle from the normal class schedule, indicating likelihood of having had to repeat either a prerequisite course or statics itself. These results hint at a difference in student rather than difference in instructional method.

The four URU courses each took the full, 27-question online CATS assessment as pre-test and post-test, allowing both a pre- post-test comparison and insight into the validity of an abbreviated, four-question CATS assessment. Friction-related questions were not included in this analysis because all sections had not covered friction topics in class at the time the CATS assessment was administered. As shown in Table 2, the full CATS assessment garnered higher scores among each of the four URU sections that took the entire instrument. While the percentage of questions marked as accurate are not equivalent, the ranking of sections remains consistent (lowest score to highest score). The scores from the URU classes are much lower than those of a 2005 study of 245 students at Carnegie Mellon. In the study, Steif and Dantzler (2005) show the reliability and validity in the CATS assessment and report a posttest average of over 70 percent in these students. These are the creators of the CATS and their students are potentially more familiar with the style of question posed in the assessment. Results such as these provide the means for an instructor to benchmark his or her class against a norm and plan for improvement.

Table 2. Comparison of Four Questions CATS to Full CATS Scores

URU Section	% Average 4Q CATS	% Average full CATS
1	28.1	38.0
2	28.7	37.7
3	19.1	29.1
4	21.7	34.1

Initial results show an inconsistent correlation between grade earned in the statics course and the score on the CATS assessment. For the sections taught at URU, the correlation coefficients ranged from -0.385 to 0.267. Individual grades and CATS test scores were not recorded for the other two sections. Furthermore, as shown in Table 3, instructor grading practices varied greatly among the three instructors. The instructor for MRU1 issued “A” grades to 58 percent of the students in his class. MRU2 only issued grades of “A” to 16 percent of students in his class and the instructor at URU awarded an “A” to 24 percent of students in her class as averaged across the four sections. This data shows that the grade awarded to a student is inconsistent with the individual’s CATS score and varies dramatically by instructor. This is presumably due to grading philosophy. Karimi and Manteufel (2013), in their study of thermodynamics, note a similar divergence of assigned grades (focusing on the number of students with a grade below a C-) based on instructor. Grades in the follow-on course (Thermodynamics II) depended upon their instructor for Thermodynamics I instead of upon the grade assigned, showing that a student’s assigned grade does not always align with the student’s level of conceptual knowledge²².

The quality of the students can also vary, as indicated by the large differences in sections at URU that were taught by the same instructor. However, given that statics is a pre-requisite for later courses in the curriculum, it is hoped that there would be some consistency at the low end of the grading scale; if students are required to earn a C- or better to proceed to courses that require statics as a prerequisite, one would hope instructors could reasonably align on which students are prepared for future courses and which students are not.

Table 3. Grade and CATS score summary per section

SP2014	Average Grade	A	B	C	C- or below	D or F	CATS 4Q average
MRU1	3.31	58%	26%	12%	9%	5%	38.3%
MRU2	2.46	16%	36%	36%	30%	12%	38.0%
URU							
FA2013	2.49	17.0%	41.4%	24.0%	21.9%	14.6%	28.2%
SP2014-1	3.00	35.7%	42.8%	17.8%	10.7%	3.5%	28.7%
SP2014-2	2.79	10.5%	68.4%	15.8%	10.5%	5.3%	19.1%
SU2014	2.83	33.3%	28.6%	28.6%	9.5%	4.8%	21.7%

Student satisfaction with the course

Student attitudes reflected in the course evaluations are shown below in Table 3. The course evaluations show that students were more favorable to a course when the teaching style was more reformed based on RTOP value.

Table 4. Student end-of-semester evaluations of course and faculty member RTOP score

Course	Average Course (1-6)	Average Instructor (1-6)	RTOP score
MRU1	4.65	4.92	28
MRU2	5.41	5.69	74
URU (avg)	5.0	5.1	51

Researchers facilitated focus groups in the MRU1 section of statics. Students report that they find it more interesting when the instructor connects the statics concepts to real world situations. They also report liking the fact that the instructor posts additional notes and examples of solved problems to the course website.

"I couldn't get through the course with just the book. But his notes are very well put together and they are always like 70 pages for 5 lectures. They are fairly comprehensive. If I'm confused on the homework, I can go and look at the notes and find a problem similar to that and learn how to do it."

Students reported appreciating that exams were as expected:

"It's really helpful. As far as homework is concerned and the tests, they are really similar. That's very good since it's all we do ... I feel like he doesn't try to trick you on the tests. It's fair."

Various students noted ideas that would improve their satisfaction with the course:

"I wish were allowed to have group discussions. He's pretty strict in terms of like discussing things with your peers that's related to the material. I'd like if we had time to work through problems with peers. It would be helpful."

"I think it would be beneficial if we did group projects where he posts a problem and you work on it."

Students reported being happy with the class in giving the class a 4.62/6 rating. Similarly, they report being happy with the instructor in giving him a 4.92/6 rating. However, suggestions for improving the course center on more active learning methods, offering an opportunity for the instructor to improve.

SALG results were compared between the MRU2 (RTOP = 74) and URU (RTOP = 51) instructors. The SALG has two relevant categories, one that focuses on student gains in understanding of the main course concepts, how these concepts fit into other classes, and how

these concepts help people address real-world issues and one that focuses on student learning gains based on aspects of the class such as attending lecture, participating and listening in class, and doing group work in class. Researchers ran two-tailed t-tests between the two sections between the MRU2 section and the URU sections and found no significant differences in student response. Individual questions and student score (scale of 1-5) are shown in Table 5 for the MRU 2 class and the average of the three URU classes where the SALG was administered. The largest nominal differences between the two relate to the instructional approach taken in the class and the amount of group work in the class. These two factors strongly align with the clear differences between the flipped classroom at MRU 2 and the only moderately active and group-work focused classroom at URU.

Table 5. Summary of average SALG responses

Topic and Question (answers range 1-6; 6 is highest)	MRU 2 n = 33	URU avg n = 59	URU std dev
HOW MUCH did the following aspects of the class HELP YOUR LEARNING?			
The instructional approach taken in this class	4.7	4.2	0.06
HOW MUCH did each of the following aspects of the class HELP YOUR LEARNING?			
Attending lectures	4.4	4.5	0.10
Participating in discussions during class	4.2	4.3	0.23
Listening to discussions during class	4.1	4.4	0.15
Participating in group work during class	4.6	4.1	0.21
Doing hands-on classroom activities	4.4	4.1	0.21
Specific Class Activities			
Lecture	4.0	4.3	0.23
Working on problems with partner	4.2	4.2	0.23
Going over problem solutions together in class	4.5	4.5	0.17
Demonstrations in the lab	3.8	3.6	0.40

The SALG also provided students the opportunity to comment on how their course's instructional approach helped their learning. For MRU2, student commented that they enjoyed clicker questions, class worksheets, and working in groups to answer problems. One student commented on how the instructional method used in the class made him feel:

"I felt more important and involved in the class. The style of teaching results in a relaxed, focused, and progressive atmosphere."

For the URU classes, students commented that working problems with a partner in class was key – that they enjoyed being active in class and exploring concepts instead of only copying the instructor's work. However, there were students who expressed hesitation in diving into student driven problem solving in class:

“The in class participation challenged the class to think and understand the lecture material. However, at times, I was overwhelmed because I felt I should see an example problem undergone by the instructor first hand.”

This opinion highlights that some students have not seen a more active instructional approach before and are hesitant to explore concepts before fully knowing or being shown how to solve a problem. Students may be initially resistant to active learning methods because they involve so much more engagement than a simple lecture section. Instructor decisions on how to teach may be affected by students who are uncomfortable with active learning.

Conclusions and Future Work

Conclusions to this preliminary research focus on faculty members' attitudes, student statics knowledge, and student satisfaction with statics courses. For the three instructors interviewed, faculty attitude toward teaching undergraduates aligned with the teaching methods used. Faculty members who indicated an interest in student-focused teaching utilized more active instructional methods. Faculty members who did not express as much previous training in teaching specifically (the tenure-track faculty and the adjunct faculty) scored lower values on the RTOP, indicating that their class was less reformed.

Based on the small sample size studied, class grades were not statistically correlated to teaching method or concept inventory scores. Teaching method and concept inventory scores were not related either. This data can be improved by studying in more classes and also in implementing the concept inventory in its entirety, instead of only in part. The CATS assessment is easily administered in an online format²³ for students to complete as homework and at their own pace. The online tool summarizes results as well as provides a spreadsheet of results to download and offers a clear pre- and post-test administration option as needed.

Student evaluations were more favorable for the classrooms that have a higher RTOP score, which indicated a higher level of reformed teaching. In the case of the lowest RTOP scoring classroom, the students reported, in focus groups, general approval of the course and how it was taught. A brief, informal study of the courses generally taken by students in MRU1 prior to their statics course show varying levels of “reformed” teaching. While the physics program is known for using active learning techniques (conceptual clicker questions), the math program uses more traditional lecture methods.

Based on this preliminary study, researcher interest has evolved to include studying a larger variety of courses that students typically take in the sophomore or junior year. This pool of courses includes classes like dynamics, materials, fluids, thermodynamics, and electric circuits. Expanding the courses studied will provide a larger pool of instructors. Furthermore, future research will use the Active Learning Inventory Tool²⁴ to provide a clearer assessment of how instructors implement active learning techniques in the classroom.

Because faculty interest seems so clearly to drive choice of instructional method used, future work will focus only on instructors who use some level of active learning in class. The future study will seek to determine whether any common characteristics exist among instructors who

use active learning, in order to identify practices that would encourage more widespread adoption of active learning in engineering science courses.

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