Board 215: Applying Research Results in Instructor Development to Reduce Student Resistance to Active Learning: Project Update

Ms. Lea K. Marlor, University of Michigan

Lea Marlor is a Ph.D. candidate at the University of Michigan, studying Engineering Education Research. She joined the University of Michigan in Sept 2019.

Previously, she was the Associate Director for Education for the Center for Energy Efficient Elec

Dr. Cynthia J. Finelli, University of Michigan

Dr. Cynthia Finelli is Professor of Electrical Engineering and Computer Science, Professor of Education, and Director and Graduate Chair for Engineering Education Research Programs at University of Michigan. She is Fellow of both the ASEE and the Institute for Electrical and Electronics Engineers (IEEE), associate editor for the European Journal of Engineering Education, and member of the Governing Board of the Research in Engineering Education Network. She was previously chair of EECHA, chair of the ERM Division of ASEE, co-chair of the ASEE Committee on Scholarly Publications, deputy editor for the Journal of Engineering Education, and associate editor for IEEE Transactions on Education.

Dr. Finelli studies the academic success of students with attention-deficit/hyperactivity disorder (ADHD), social justice attitudes in engineering, and faculty adoption of evidence-based teaching practices. She also led a project to develop a taxonomy for the field of engineering education research, and she was part of a team that studied ethical decision-making in engineering students.

Dr. Michael J. Prince, Bucknell University

Dr. Michael Prince is a professor of chemical engineering at Bucknell University and co-director of the National Effective Teaching Institute. His research examines a range of engineering education topics, including how to assess and repair student misco

Dr. Jenefer Husman, University of Oregon

Jenefer Husman, Professor in the Education Studies department at the University of Oregon. Her research focuses on students' motivation for learning in engineering contexts. She is particularly interested in the ways students' thoughts about the future influence their effort, choice, and self-regulation.

Dr. Matthew Charles Graham
Ariel Chasen, University of Texas, Austin

PhD Student in STEM education at University of Texas at Austin

Applying Research Results in Instructor Development to Reduce Student Resistance to Active Learning: Project Update

Abstract

In this paper we provide an update in our research studying science, technology, engineering, and mathematics (STEM) instructor development in classrooms. Our overarching goal is to expand the adoption of active learning in STEM classrooms. For this study, we created a workshop to educate STEM instructors on what active learning is and ways to implement it into their classrooms. Additionally, this workshop sought to provide instructors with evidence-based strategies that focused on reducing student resistance to active learning. This study used a conducted randomized control trial to investigate the impact of this workshop on: (1) how this workshop impacted STEM instructors' attitudes towards using active learning, (2) their behaviors in using active learning, and (3) their use of strategies for reducing student resistance to active learning. We collected data from 173 instructors and 1676 students.

This paper focuses on our preliminary results as well as next steps for the project. Thus far, we have analyzed the impact of the workshop on our instructor's use of active learning, and the student responses to these changes.

Introduction

Active learning has been shown to improve student grades, retention rates, and overall understanding of course material [1-6]. We define active learning as any time an instructor goes beyond lecturing to their students where the students are passively learning material (e.g., think-pair-shares, class discussions) [7, 8]. Research has shown adoption of active learning in STEM courses has been slow with one common cited reason for not implementing active learning in their courses being the fear of student resistance [5, 9-12]. Student resistance can be defined as any negative student reaction to active learning (e.g., distracting others, giving lower course evaluations, or refusing to participate in the activity).

Our past research has identified strategies instructors can use to reduce student resistance in their classrooms[13-16]. These strategies have been broadly categorized as 1) *planning strategies:* how an instructor prepares course material, including using student feedback or assessing past activities; 2) *explanation strategies:* how an instructor introduces or explains an activity to students, including its goals and purpose; and 3) *facilitation strategies:* how an instructor can keep students engaged in the activity itself, such as walking around the room and answering students' questions.

Study Design

To help instructors reduce student resistance in their classrooms, we created an online instructor development workshop that focused on guiding instructors on what active learning is, how to implement it, and strategies on how to reduce student resistance. We used a randomized control trial (RCT) to test the efficacy of the workshop and understand its impact on both instructor behaviors and attitudes towards using active learning as well as their student responses to active learning.

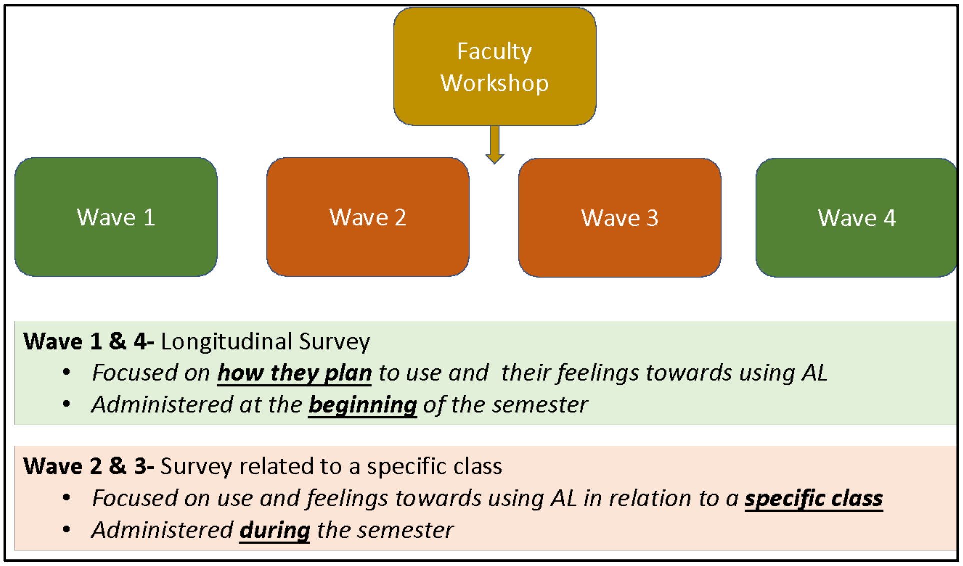

Figure 1: Timeline of data collection

To conduct this RCT, we recruited instructors in the Summer of 2021 and randomly assigned them to either a control group (which participated in our workshop after all data was collected for this study) or an intervention group (which participated in our workshop during the data collection). We collected data from participants in both groups three times in Fall 2021 and once in Winter/Spring 2022. Instructors were surveyed twice before the workshop intervention (Wave 1 and Wave 2 surveys) and twice after the workshop (Wave 3 and Wave 4 surveys). A timeline of this data collection can be found in Figure 1. The Wave 1 and Wave 4 surveys were focused on the instructors general attitudes towards active learning and were administered at the start of the Fall 2021 and Winter 2022 semesters, respectively. The Wave 2 and Wave 3 surveys focused around a single class where active learning was being used. The instructor's students were also surveyed during Wave 2 and Wave 3.

The survey instruments were developed and validated in our past research [15, 17, 18]. An outline of the focus of these surveys can be found in Figure 2. The instructor surveys asked how they currently used active learning, how confident the felt in using active learning, the value they saw in using active learning. They were also asked how likely they were

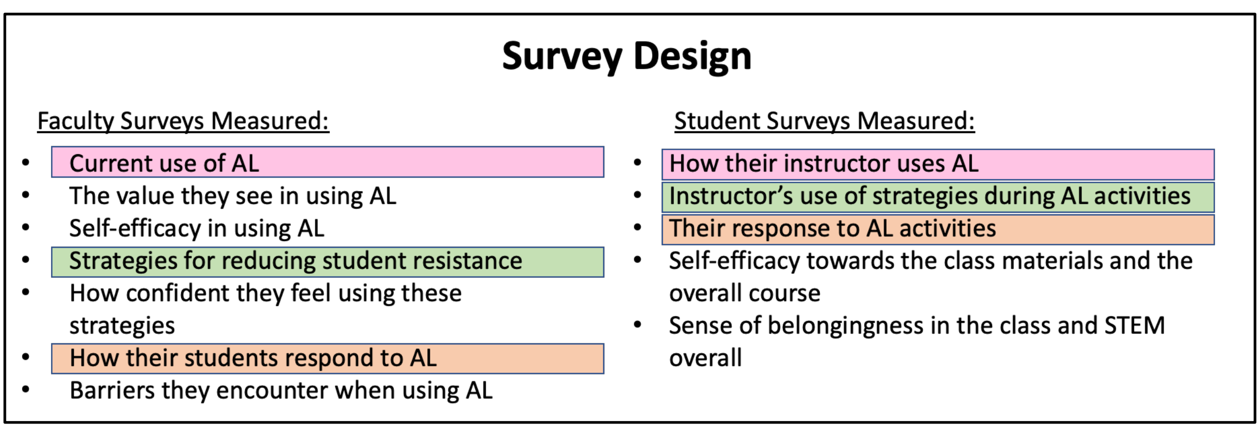

Figure 2: Sections for the instructor and student surveys. Like colors are for analogous topics.

to use different strategies for reducing student resistance, how valuable they found these strategies, and their confidence in using them. They were then asked about how they believed their students responded to their use of active learning, such as the students were distracted or not engaged in the active learning activities. Finally, they were asked about the barriers that they faced when trying to implement active learning in their classrooms.

Instructor and student surveys were aligned so that we could learn how student and instructor perceptions are comparable for each individual class. The student survey asked about their instructor's use of active learning and if their instructor used different strategies for implementing active learning. Additionally, we measured the student response to active learning including their affective and behavioral responses. Finally, we asked questions about their feelings of belongingness in their STEM classes as well as their self-efficacy in these courses.

Preliminary Findings

To understand the effectiveness of our active learning workshop, we ran preliminary repeated measurement ANOVAs on our data set. Specifically, we looked at how the instructors and students in the control group compared to the instructors and students in the intervention group. These measurements allowed for a high-level look at the data as a whole. When looking at the instructor surveys from Wave 2 and Wave 3, we found increases in 1) the value they saw in using active learning, 2) the instructor's self-efficacy in using active learning, 3) their use of the strategies to reduce student resistance, and 4) how confident they were in using these strategies. An example result (self-efficacy) is shown in Table 1. These increases were found across all instructor surveys, regardless of if they received the intervention and there were only small, insignificant differences found between the control and intervention groups. A possible explanation for why we saw these increases, regardless of if they participated in our workshop, could be that the act of taking a survey about active learning caused the instructor to think critically about their active learning use in their classrooms. Past research has shown that surveys themselves can serve as interventions, and it is possible that this occurred in our sample [19]. Additionally, we observed a ceiling effect within our data in that all of the instructors had

Active Learning Self-Efficacy		Mean	Std. Deviation	N
Wave 2	Control	7.740	1.3861	57
	Intervention	8.034	1.4317	77
	Total	7.909	1.4148	134
Wave 3	Control	8.200	1.3027	57
	Intervention	8.270	1.1769	77
	Total	8.240	1.2277	134

Table 1: Instructor Self-Efficacy towards using active learning.

positive feelings surrounding active learning. This is not surprising, given that faculty that sign up for a workshop on active learning likely already believed in the benefits of active learning prior to signing up. This selection bias and the ceiling effect likely obfuscated our data and analysis of the effectiveness of our workshop.

While instructors reported a change in their active learning use and strategies in their classrooms, those changes were not translated to changes in the student experiences of those same classrooms. Student survey responses demonstrated little to no change in their responses to active learning, regardless of if their instructor participated in the workshop. Tables 2 and 3 show selected repeated measure ANOVAs for affective and behavioral responses of students towards active learning in their classrooms. The changes seen from students are not significant.

Tests of Within-Subjects Effects						
	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intervention	0.016	1	0.016	0.036	0.850	0.000
Control	0.045	1	0.045	0.101	0.751	0.001
Error(ARPS)	60.491	135	0.448			

Table 2: Student Affective Response- Positivity towards active learning.

Tests of Within-Subjects Effects						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intervention	0.066	1	0.066	0.116	0.733	0.001
Control	0.001	1	0.001	0.002	0.968	0.000
Error(ARV)	76.253	135	0.565			

Table 3: Student Behavioral Response- Evaluation of the course.

Next Steps

While our preliminary results have not shown differences between our control and intervention groups, we plan to dig further into our data and do more complex analyses to find potential differences that cannot be shown using ANOVA. Additionally, we will look at different types of active learning (interactive versus constructive) to determine how these types of teaching impact student responses. Finally, we plan to determine what differences can be found between different types of institutions (such as community colleges, MSIs, PWIs, Doctoral granting institutions) or class types (engineering, science, math).

Acknowledgements
This research is supported by the U.S. National Science Foundation (grant numbers DUE-1821092, DUE-1821036, DUE-1821488, and DUE-1821277). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

[1] L. Deslauriers, L. S. McCarty, K. Miller, K. Callaghan, and G. Kestin, "Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom," *Proceedings of the National Academy of Sciences,* vol. 116, no. 39, p. 19251, 2019, doi: 10.1073/pnas.1821936116.

[2] S. Freeman *et al.*, "Active learning increases student performance in science, engineering, and mathematics," *Proceedings of the National Academy of Sciences,* vol. 111, no. 23, p. 8410, 2014, doi: 10.1073/pnas.1319030111.

[3] S. Gauci, A. Dantas, D. Williams, and R. Kemm, "Promoting student-centered active learning in lectures with a personal response system," *Advances in physiology education,* vol. 33, pp. 60-71, 03/01 2009, doi: 10.1152/advan.00109.2007.

[4] D. C. Haak, J. HilleRisLambers, E. Pitre, and S. Freeman, "Increased Structure and Active Learning Reduce the Achievement Gap in Introductory Biology," *Science,* vol. 332, no. 6034, p. 1213, 2011, doi: 10.1126/science.1204820.

[5] T. J. Lund and M. Stains, "The importance of context: an exploration of factors influencing the adoption of student-centered teaching among chemistry, biology, and physics faculty," *International Journal of STEM Education,* vol. 2, no. 1, p. 13, 2015/08/18 2015, doi: 10.1186/s40594-015-0026-8.

[6] J. Michael, "Where's the evidence that active learning works?," *Advances in Physiology Education,* vol. 30, no. 4, pp. 159-167, 2006/12/01 2006, doi: 10.1152/advan.00053.2006.

[7] M. Prince, "Does Active Learning Work? A Review of the Research," *Journal of Engineering Education,* https://doi.org/10.1002/j.2168-9830.2004.tb00809.x vol. 93, no. 3, pp. 223-231, 2004/07/01 2004, doi: https://doi.org/10.1002/j.2168-9830.2004.tb00809.x.

[8] M. Prince and R. Felder, "The Many Faces of Inductive Teaching and Learning," *The journal of college science teaching,* 2007.

[9] M. H. Dancy and C. Henderson, "Experiences of new faculty implementing research-based instructional strategies," *AIP Conference Proceedings,* vol. 1413, no. 1, pp. 163-166, 2012/02/08 2012, doi: 10.1063/1.3680020.

[10] J. Froyd, M. Borrego, S. Cutler, C. Henderson, and M. Prince, "Estimates of Use of Research-Based Instructional Strategies in Core Electrical or Computer Engineering Courses," *Education, IEEE Transactions on,* vol. 56, pp. 393-399, 11/01 2013, doi: 10.1109/TE.2013.2244602.

[11] C. Henderson and M. Dancy, "Impact of physics education research on the teaching of introductory quantitative physics in the United States," *Physical review special topics. Physics education research,* vol. 5, 12/01 2009, doi: 10.1103/PhysRevSTPER.5.020107.

[12] S. E. Shadle, A. Marker, and B. Earl, "Faculty drivers and barriers: laying the groundwork for undergraduate STEM education reform in academic departments," *International Journal of STEM Education,* vol. 4, no. 1, p. 8, 2017/04/13 2017, doi: 10.1186/s40594-017-0062-7.

[13] C. J. Finelli and M. Borrego, "Evidence-Based Strategies to Reduce Student Resistance to Active Learning," in *Active Learning in College Science: The Case for Evidence-Based Practice*. Cham: Springer International Publishing, 2020, pp. 943-952.
[14] C. J. Finelli *et al.*, "Reducing Student Resistance to Active Learning: Strategies for Instructors," (in English), *Journal of College Science Teaching,* vol. 47, no. 5, pp. 80-91, May/Jun
May/Jun 2018
2018-05-09 2018.
[15] K. Nguyen *et al.*, "Students' Expectations, Types of Instruction, and Instructor Strategies Predicting Student Response to Active Learning," *International Journal of Engineering Education,* vol. 33, pp. 2-18, 01/01 2017.
[16] S. Tharayil *et al.*, "Strategies to mitigate student resistance to active learning," *International Journal of STEM Education,* vol. 5, no. 1, p. 7, 2018/03/12 2018, doi: 10.1186/s40594-018-0102-y.
[17] M. DeMonbrun *et al.*, "Creating an Instrument to Measure Student Response to Instructional Practices," *Journal of Engineering Education,* https://doi.org/10.1002/jee.20162 vol. 106, no. 2, pp. 273-298, 2017/04/01 2017, doi: https://doi.org/10.1002/jee.20162.
[18] K. Nguyen *et al.*, *Measuring Student Response to Instructional Practices (StRIP) in Traditional and Active Classrooms*. 2016.
[19] A. P. Zwane *et al.*, "Being surveyed can change later behavior and related parameter estimates," *Proceedings of the National Academy of Sciences,* vol. 108, no. 5, pp. 1821-1826, 2011.