Promoting adoption of active learning and use of strategies to reduce student resistance to active learning

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***Abstract**: Our research has identified strategies instructors can use to reduce student resistance to active learning, and we are developing a workshop intervention to change instructors' motivation and behaviour related to adoption of active learning and of these strategies. We are using a randomized control trial to assess the impact of the workshop on instructors' value, self-efficacy, and actual adoption of both active learning and the strategies to reduce resistance. In this paper, we describe our processes for recruiting workshop participants and for developing an instructor survey to assess the impact of the workshop.*

Keywords

Active learning, faculty development, motivation, student resistance

Introduction

There is convincing evidence about the positive benefits of implementing active learning in Science, Technology, Engineering, and Math (STEM) classrooms, both in the United States and internationally. Active learning – which we define as students doing anything in class to learn material, other than listening to the instructor and taking notes – has been shown to improve student learning, engagement, and interest in STEM (Freeman et al., 2014; Koch, Dirsch-Weigand, Awolin, Pinkelman, & Hampe, 2017; Lucke, Dunn, & Christie, 2017; Prince, 2004; Rodríguez et al., 2015; Seymour & Hewitt, 1997; Smith, Sheppard, Johnson, & Johnson, 2005; Yusof, Tasir, Harun, & Helmi, 2005), promote success for a diverse student body (Seymour & Hewitt, 1997; Tobias, 1990), and increase the retention rate of students in STEM programs (Blackburn & Lawrence, 1995; Freeman et al., 2014). Yet, in spite of the overwhelming evidence of the efficacy of active learning, adoption of active learning in undergraduate STEM classrooms has been limited (Dancy, Henderson, & Turpen, 2016; Gradinscak, 2011; Jamieson & Lohmann, 2012; Stains et al., 2018). Thus, one key challenge now is to increase the use of active learning in STEM by addressing barriers to adoption.

Instructors cite multiple barriers that inhibit their adoption of active learning (e.g., Finelli, Daly, & Richardson, 2014; Henderson & Dancy, 2007; Seidel & Tanner, 2013), including concerns about: (a) the efficacy of active learning; (b) the preparation time required to implement it; (c) class time and the instructor's ability to cover the syllabus; and (d) student resistance. While instructor concerns about the *efficacy* of active learning are a legitimate barrier, this efficacy has been exhaustively documented, as we outlined above; thus, it requires little additional research. Similarly, concerns about both preparation and class time have been addressed convincingly in the literature (Felder, 1992, 1994; Felder & Brent, 2009). However, student resistance (i.e., any negative student response to active learning that would discourage an instructor from using that activity, including refusing to participate, distracting others, or giving low course evaluations) has not been the subject of significant research. We therefore focus on student resistance as the most actionable barrier to the adoption of active learning.

Through our previous research involving classroom observations, instructor interviews, and student surveys in 19 diverse STEM courses across the United States, we found that students most often responded positively when their instructors asked them to engage in active learning (DeMonbrun et al., 2017). Student resistance to active learning was not common, and when it did happen, it generally manifested as passive behaviour rather than open, confrontational behaviour (Nguyen et al., 2017).

Our research further identified several promising strategies that can reduce student resistance to active learning. Specifically, instructor's use of *explanation* strategies to introduce an activity and describe its purpose, *facilitation* strategies to promote engagement and keep the activity running smoothly, and *planning & feedback* strategies to plan the activity, assess its success, and use feedback to improve it are related to greater student participation, less distraction, and higher course evaluations (Finelli et al., 2018; Nguyen et al., 2017; Tharayil et al., 2018).

Now, armed with these strategies to reduce resistance, we aim to promote adoption of active learning among STEM instructors through a workshop that will both address the benefits of active learning and help instructors use these strategies to reduce resistance. Our workshop focuses on changing instructors' behaviour by increasing their motivation (i.e., value and self-efficacy) for using both active learning and the strategies to reduce resistance. Accordingly, we ground the design of our workshop in the Expectancy Value Theory of motivation (Eccles & Wigfield, 2002) as well as in prior research about active learning (e.g., Prince, 2004), student resistance to active learning (DeMonbrun et al., 2017; Finelli et al., 2018), and faculty professional development (Felder, Brent, & Prince, 2011).

STEM-focused faculty professional development programs, including single- or multi-day teaching workshops like ours, have become increasingly common across the United States (Jamieson & Lohmann, 2012; Felder, Brent, & Prince, 2011). Such programs have been shown to affect instructors' behaviour (Condon, Iverson, Manduca, Rutz, Willett, & Huber, 2015; Gibbs & Coffey, 2004) and to be an efficient way for instructors to improve teaching (Felder, Brent, & Prince, 2011). Thus, we expect that our workshop will influence instructors' use of active learning and the strategies to reduce resistance.

We will hold identical workshops for instructors who teach introductory STEM courses in three separate regions of the United States: the Midwest, South, and West, and we will conduct our project as a Randomized Control Trial (RCT) by randomly splitting participants into an intervention group and a comparison group. Instructors assigned to the intervention group will participate in the workshop during Year 1, while instructors assigned to the comparison group will participate during Year 2. Thus, by the end of the two-year project, instructors in both groups will have participated in the workshop. For both groups, we will assess the instructors' motivation for using both active learning and the strategies to reduce resistance and their actual behaviour by collecting and analysing data from multiple sources, including classroom observations, instructor surveys, and student surveys. Triangulating and comparing these data for the intervention and comparison groups both before and after the workshop will allow us to study the impact of the workshop.

For this Work-in-Progress paper, we describe two components of the larger project: participant recruitment and our instructor survey to assess the impact of the workshop on instructors' motivation and behaviour. Future publications will more fully address the design of our workshop and other data collection instruments, and we will broadly share our research findings as they become available.

Methods

Participants

Several design decisions influence our process for recruiting workshop participants. These include how we: (1) define introductory STEM courses, (2) identify eligible STEM instructors, and (3) form the intervention and comparison groups for our RCT.

1. *Introductory STEM courses*

There has been little research about course-related factors that might influence student resistance to active learning (e.g., the discipline of the course, whether the course is required or elective, whether the course comprises introductory or advanced material). Thus, we focus on promoting the use of active learning and strategies to reduce resistance in introductory STEM courses in the United States to reduce variability in classroom context, and we begin by clarifying a working definition of *introductory STEM courses*.

A number of possible definitions for STEM have been discussed in the literature (Koonce et al., 2011), and these definitions differ primarily in two ways: how broadly the term "STEM" is interpreted, and whether or not the social sciences and healthcare are included. We adopt the convention recommended by the United States Government Accountability Office (2014) by including core STEM fields in our definition. Under this categorization scheme (Figure 1), our definition of STEM includes engineering, life sciences, physical sciences, computer and information technology, and mathematics and statistics. Further, we define introductory STEM courses as first- or second-year courses in one of the core STEM fields that are both (1) primarily targeted to students within the first two years of a nominal four-year degree program or offered by a two-year institution and (2) offered by a STEM department or judged to have course content that falls substantially within one of the STEM fields.

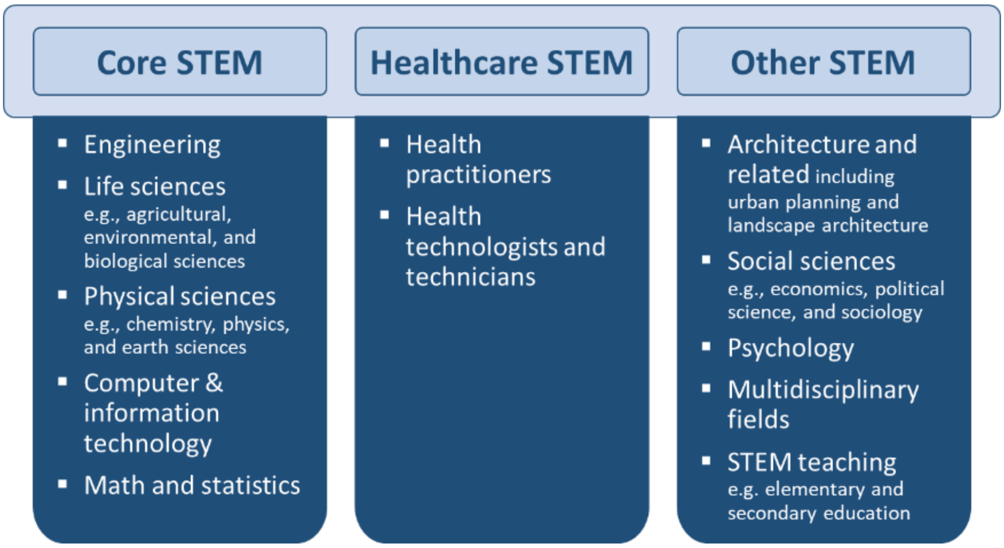

Figure 1. Definition of STEM fields (adapted from United States Government Accountability Office (2014))

2. *Eligible STEM instructors*

Our systematic process for recruiting instructors who teach introductory STEM courses involves identifying eligible college and universities in the United States, compiling contact information for relevant administrators and instructors at those institutions, and then inviting workshop participants. To be eligible for our project, an institution must satisfy three requirements. First, because we will conduct in-class observations of our participants, we restrict our research to institutions within a 150-mile driving distance of the three regional workshop locations (Ann Arbor, Michigan in the Midwest; Austin, Texas in the South; and Eugene, Oregon in the West). Second, because it involves instructors teaching introductory

STEM courses, we restrict our research to institutions having a STEM department, program, major, or (if none of those exist) introductory course. And third, we restrict our research to public or not-for-profit private institutions and to two- or four-year institutions.

To identify eligible institutions, we merged data from the CollegeNavigator online database (National Center for Education Statistics, 2018) and the Integrated Postsecondary Education Data System (National Center for Education Statistics, 2015), compiled the driving distance for all institutions within 150 miles from the closest regional workshop location (using zip code), and determined whether those institutions offered a STEM degree. We also recorded additional information for each institution including Carnegie Classification®, size, and setting, by consulting the Carnegie Classifications of Institutions of Higher Education® database (Indiana University Center for Postsecondary Research, 2016).

Next, we reviewed each eligible institution's website to collect contact information of either a relevant administrator who would forward our email invitation to workshop candidates or the candidates themselves. Specifically, for every STEM department/program/degree at the eligible institution, we first looked to identify contact information of a relevant administrator (STEM department chairperson, unit head, or key faculty contact) on the institution's website. If that information was not available or if the STEM program did not have a relevant administrator, we collected contact information for workshop candidates as follows:

- If less than ten instructors were listed, we added contact information for all instructors,
- If either ten or more instructors were listed or none were listed, we included the contact information for the Dean,
- If ten or more instructors were listed and the Dean was not listed, we included contact information for ten instructors selected randomly from the institutions' webpage, and
- If none of this information was available, then the institution was dropped from our list.

Now, after having compiled contact information, we will recruit participants by sending targeted email invitations to individuals on each recruitment list approximately three months before each regional workshop. Our recruitment emails either will either ask relevant administrators to forward the invitation to instructors in their program who teach introductory STEM courses or will personally invite instructors to participate in the workshop (and encourage them to forward the message to their colleagues). The emails will further describe that, to be eligible for the project, instructors must plan to teach an introductory STEM course during both Years 1 and 2 of the project, and they must be available to attend the workshop during both years.

3. *Intervention and comparison groups*

Instructors who are interested in participating in our project will complete a baseline questionnaire with items about instructor demographics, background characteristics, prior experiences with active learning, and a target class session in which the instructor plans to adopt active learning (e.g., approximate student enrolment, programs or majors that require the course, class level of students, etc.). We will use data from the baseline questionnaire in two ways. First, we will screen out instructors who do not satisfy the inclusion criteria; i.e., those who do not expect to teach an introductory STEM course during both Years 1 and 2 and those who are unable to attend the workshop on both pre-scheduled workshop dates. Second, we will use data from the instructors who do satisfy our inclusion criteria to create two equivalent groups (Intervention and Comparison) for each of the three regions, asking instructors in the intervention group to participate in the workshop during Year 1, while asking instructors in the Comparison group to delay their participation until Year 2. We will utilize block randomized assignment to ensure that both groups have equal representation of instructors having various characteristics (e.g., teaching at two- and four-year institutions), allowing us to conduct our project as an RCT.

In the medical field, RCTs are considered the gold standard for establishing the efficacy of a clinical intervention, since they allow for the study of a treatment when it is not possible to control for or isolate all possible relevant variables. Owing to the success of RCTs in clinical research, many educational policy makers and researchers have pushed for RCTs in educational contexts, arguing that educational policy should be shaped by the available scientific evidence regarding the efficacy of educational interventions. The efficacy of RCTs in educational research, though, is controversial. Research reports from the National Academy of Education (e.g., Singer, Braun, & Chudowsky, 2018) do feature RCTs as the gold standard for determining causality of an educational intervention, but others agree that applying RCTs to educational contexts can be problematic (e.g., Sullivan, 2011). It is often not possible to control for the many sources of error that may occur in real-world educational settings, such as differences in personal characteristics of participants, differences in the intensity of the intervention, and institutional inequities, and the random assignment of individuals to comparison groups can potentially harm participants in the comparison group if valuable treatment is withheld from them (Cohen, Manion, & Morrison, 2018; Sullivan, 2011).

We acknowledge that issues related to institutional inequities may present a limitation to our research. We further acknowledge that we will be unable to control many of the factors that might be important our study, such as the teaching experience of each instructor, the instructor's prior use of and success with active learning, the content of the course, and the culture of the institution. However, using a block randomized assignment process ensures that these differences between participants will occur at random.

We are confident that the RCT will not harm participants in either the intervention or comparison group. Considerable prior research has demonstrated the efficacy of both active learning and the strategies to reduce student resistance, and we have extensive faculty professional development and workshop delivery experience, so there is no likely harm to the intervention group from participating in our workshop. Further, the comparison group will have delayed participation in the workshop (they will participate during the second year); so since the workshop will not be withheld from them, there is no likely harm to the comparison group. The institutional review boards at the three regional workshop sites have each approved these research plans.

Instructor survey

We aim to explore the impact of our workshop on instructors' motivation (i.e., value and self-efficacy) and behaviour related to adoption of active learning and the strategies to reduce student resistance to active learning. We will collect data for both the intervention and comparison groups from three sources: instructor surveys, student surveys, and classroom observations, all administered at multiple times during both Years 1 and 2. Table 1 shows the approximate timeline for data collection. Here, we describe our instructor survey.

Table 1. Data collection timeline for intervention (INT) and comparison (COMP) group

	Instructor Survey		Student Survey		Class Observations	
Year 1	**INT**	**COMP**	**INT**	**COMP**	**INT**	**COMP**
Before workshop (June 2019)	*					
After workshop (June 2019)	*	*				
During the semester (Oct 2019)	*	*	*	*	*	*
Year 2						
Before workshop (June 2020)		*				
After workshop (June 2020)	*	*				
During the semester (Oct 2020)	*	*	*	*	*	*

We will administer the instructor survey two times each year to all participants in both the intervention and comparison groups: the day before the workshop and once during the following semester. Workshop participants will also complete the instructor survey immediately after the workshop. Participants will identify a *target class session*, approximately half way into the semester in which they plan to use active learning. We will administer the instructor survey on the day of the target class session, allowing instructors to respond to items about that specific class period.

Drawing on our team's prior research (DeMonbrun et al., 2017), our instructor survey includes a five-item "active learning" scale and a 17-item "strategies to reduce student resistance" scale. We previously demonstrated both of these scales to be valid and reliable measures of student perceptions of instructor behaviour (Nguyen et al., 2016). Table 2 includes the items for both scales. When we administer the instructor survey before and after the workshop, we will use two motivational constructs, value and self-efficacy (Bandura, 2006; Eccles & Wigfield, 2002), to measure instructor motivation for using both active learning and the strategies to reduce student resistance. To assess *value*, respondents will indicate how valuable they believe it is to do each of the 22 items on the two scales, and to assess *self-efficacy*, respondents indicate how confident they are in their ability to do each item. To assess *behaviour* when we administer the instructor survey during the semester, respondents will indicate how frequently they did each item during the target class session.

Table 2. Scales for active learning and strategies to reduce student resistance

Active learning	
1.	Ask everyone in class to do a course-related activity other than watching, listening, or taking notes
2.	Give students a minute or two to think about an instructor-posed question before letting someone answer the question or calling on one or more students to answer it
3.	Ask students to discuss concepts with classmates during class
4.	Ask students to solve problems in a group during class
5.	Ask students to solve problems individually during class
Strategies to reduce student resistance	
1.	Plan the activity based on how well a similar activity worked in the past
2.	Structure the activity with small steps that students can accomplish confidently
3.	Specifically design the activity to maximize student engagement
4.	Design the activity to connect with the rest of the class period or lesson plan
5.	Use feedback from students to design the activity
6.	Following the activity, think about what did and did not work
7.	Explain what students are expected to do for the activity
8.	Explain the purpose of the activity
9.	Discuss how the activity relates to student learning
10.	Describe how the activity relates to graded assignments
11.	Solicit feedback from students about how the activity went
12.	Walk around the room to assist students with the activity if needed
13.	Encourage students to engage with the activity through your demeanour, body language, or interactions with students
14.	Approach students who are not participating in the activity if you see them
15.	During the activity, invite students to ask questions about it
16.	Give students points based on their participation in the activity
17.	Lead a debrief or report-out as a whole class following the activity

We are currently pilot testing the items on our instructor survey by conducting a scale validation study on a sample of approximately 500 STEM instructors in the United States. By the time of our REES presentation, we will have conducted a confirmatory factor analysis utilizing structural equation modeling for each scale, and we will be able to report scores of convergent validity, structural validity, and reliability of responses to the measures.

Other Project Components

1. *Workshop intervention*

We are piloting our workshop intervention in Summer 2019. The workshop has two major segments, the first of which provides an introduction to active learning for STEM instructors. The workshop facilitators will begin by defining active learning and presenting research about its effectiveness. Then, after collecting and addressing instructors' concerns about using active learning strategies, the facilitators will provide participants with both additional guidance for using active learning and with opportunities to practice it and get feedback. The second segment of the workshop will focus on strategies to reduce student resistance to active learning. The facilitators will present research showing positive correlations between use of three types of strategies (explanation, facilitation, and planning/feedback) and lower measures of student resistance, and then they will share practical examples of using the strategies with participants. Finally, participants will have opportunities to practice using the strategies and get feedback. By the end of the workshop, participants will develop an action plan to successfully adopt active learning and reduce student resistance.

2. *Other instruments*

Besides the instructor survey, our overall project involves data collection from two other sources: student surveys and classroom observations. The student survey will be administered in the middle of the semester, concurrent with the instructor survey, and it will ask students to respond about the target class session. It will be based on an instrument we developed in our prior research to assess student perceptions of instructors' use of active learning and of strategies to reduce resistance and student self-reported resistance to active learning (DeMonbrun et al., 2017). We have already established the psychometric properties of those scales (Finelli et al., 2018). The student survey will also include items about student demographics and background characteristics.

Concurrent with the student survey, we will conduct classroom observations on the day the target class session in a randomly chosen subset of one-third of the courses (split equally between the intervention and comparison groups). We are developing a standardized observation protocol, based on a similar instrument we developed in our prior research (Shekhar et al., 2015), to examine active learning used in the classroom and the strategies an instructor uses to reduce resistance. Next steps involve piloting the new observation protocol and using existing video of faculty instruction to test the validity and reliability of the scores produced by the observational rubric.

Future work

Future work for this project includes recruiting workshop participants, creating the intervention and comparison groups, facilitating the three regional workshops each year, administering the instructor survey to participants in both the intervention and comparison groups, administering accompanying student surveys, and observing instructors' use of active learning in the classroom. We also will explore relationships between instructors' motivation/behaviour and students' response to active learning, including students' affective response (i.e., value and positivity) and resistance (i.e., participation, distraction, and evaluation). Finally, we will examine how students' response to active learning influences instructors' future plans to use active learning to better understand the degree to which our workshop changes instructor motivation and behaviour and to further explore how use of the strategies can influence student behaviour in the classroom.

Conclusions

Student resistance to active learning is one of the most actionable and least studied barriers to STEM instructional change. This paper will provide researchers with (1) a framework for the systematic recruitment of instructors, and (2) validity and reliability evidence for an instructor survey to assess instructors' motivation and behaviour related to adoption of active learning and the strategies to reduce student resistance. This work will also lay the foundation for future cross-cultural work on adoption of active learning and will provide valuable insights for faculty professional development. Although student resistance and the efficacy of our strategies to reduce resistance may vary in different international contexts, we expect that our methods can be adopted by researchers in any context, and we hope that our findings will contribute to a broader understanding of student resistance to active learning.

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Acknowledgements

The authors gratefully acknowledge the efforts of other researchers on this project, including Dr. Maura Borrego, Madison Andrews, and Bobbie Bermudez. This material is based upon work supported by the National Science Foundation under Grant Numbers 1821488, 1821092, 1821036, and 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.

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