

Impact of Flexible Classroom Spaces on Instructor Pedagogy and Student Behavior

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Introduction

The use of active learning techniques, such as asking students to respond to multiple-choice “clicker” questions or to work together with their peers to solve a problem in class, has been shown to benefit students by improving their retention of information, conceptual understanding, self-esteem, and attitudes about their program of study [1], [2], [3]. However, many barriers still remain to the implementation of active learning, including insufficient training for instructors, a lack of rewards and incentives, fear of student resistance or negative student evaluations, increased preparation time, and constraints of the physical classroom [4], [5], [6], [7], [8]. “Studio classrooms,” in which students sit facing each other in small groups rather than in front-facing rows, are one solution to the barrier of physical classroom constraints [9], [10], [11], [12], [13], [14]. However, fully realizing the benefits of these spaces requires a time- and effort-intensive change in the way a course is taught, as they do not easily support lecture. In fact, holding lecture-based classes in studio classrooms has been found to have negative effects on student learning outcomes [15]. Flexible classrooms, in which the tables and chairs are easily movable and can be rearranged into different layouts, support both active and traditional classroom preferences. The open-ended design of flexible classrooms means they can be arranged into front-facing rows or small groups depending on the instructor’s needs during a given activity.

Funded by the National Science Foundation’s Division of Undergraduate Education, we are conducting a study on flexible classroom spaces to address three research questions:

1. How does instructors’ **pedagogy**, specifically their choice of learning activities and use of formative assessment, differ between a traditional lecture hall and a flexible classroom space?
2. How do instructors take advantage of the **instructional affordances** of a flexible classroom to make these changes in pedagogy?
3. How does the physical classroom space influence the ways students **frame** (interpret) and engage in group learning activities?

Background

Our three research questions are designed to address the relationships between three actors in any given course: the physical classroom space, the instructor, and the students. These two-way relationships (modeled in Figure 1) are all influenced by external factors and individual characteristics of the instructor and students.

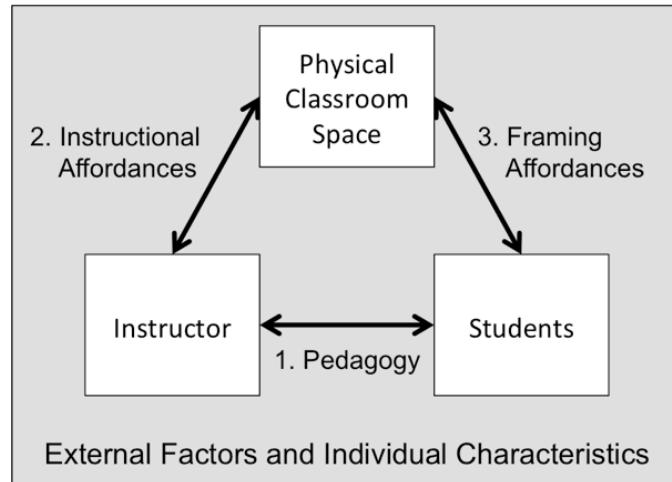


Figure 1. Conceptual model of relationships that influence teaching and learning between the physical classroom space, the instructor, and the students.

The relationship between the instructor and students is broadly labeled as the **pedagogy** employed in the class. In our research we focus on two specific aspects of an instructor's pedagogy: his/her 1) choice of learning activities and his/her 2) use of formative assessment methods. The *learning activities* employed by the instructor may be instructor-centered (e.g. lecture) or student-centered (e.g. active learning) [16], while the *formative assessment* methods may encompass any practice through which the instructor elicits and interprets evidence about student thinking and uses this evidence to make real-time changes to instruction [17].

The instructor's choice of learning activities and formative assessment methods may be influenced by the **instructional affordances** of the physical classroom space. The physical layout and technology of any given classroom suggest certain uses [10], [18]. "Studio classrooms" afford active learning more than a traditional tiered lecture hall, and research has demonstrated that student learning outcomes improve as students interact more meaningfully with their peers [15], [19], [20], [21], [22], [23]. However, studio classrooms do not easily allow for lecture-based teaching, which is still practiced by many faculty members [24], [25]. On the other hand, flexible classrooms afford both active learning and lecture, as the tables and chairs can be rearranged into layouts that support either learning activity.

Just as the affordances of a classroom can influence an instructor's pedagogy, the instructor can change and modify the classroom to fit his/her needs. This is particularly true in a flexible classroom, which is designed to be adaptable. However, just because a classroom is flexible does not mean that all instructors will use it flexibly. Norman's theory of perceived affordances [26], [27] suggests that external factors (e.g. professional development available to the instructor) and instructor characteristics (e.g. prior experience teaching the course or underlying beliefs about teaching and learning) influence each instructor's perception of a classroom's affordances and subsequent use of the space.

Finally, the way in which students interpret learning activities may be influenced by the **framing affordances** of the physical classroom space. We use the word “framing” to refer to students’ *epistemological framing*, which Scherr & Hammer define as the “sense of what is taking place with respect to knowledge” (p. 149) [28]. In other words, students make judgments about what class experiences are important and how they should engage with these experiences. This judgment is based on the physical classroom space [10], [18], as well as external factors and student characteristics such as their underlying beliefs about learning, career goals, and educational experiences to date [9], [29]. Based on their prior experiences, students may frame a room with chairs and front-facing tables as an indication that the class will mostly be lecture, and their role will be to listen passively. On the other hand, a studio classroom or flexible classroom with tables arranged in small groups may suggest to students that their role will be to actively discuss and collaboratively build knowledge with their classmates.

Study Design

The relationships between the physical classroom space, the instructor, and the students (Figure 1) in multiple courses will be assessed through three different research methods: 1) **interviews** with the instructors at the beginning and end of the semester, 2) **classroom observations** using a formal protocol, and 3) a **student survey**. Pedagogy (both learning activities and formative assessment) will be assessed from the researchers’ perspectives through classroom observations, from the instructors’ perspectives through interviews, and from students’ perspectives through the survey. The instructors’ use of the instructional affordances of the classroom will be assessed through the observations and interviews. Finally, the influence of the framing affordances of the classroom on students will be assessed through classroom observations and the student survey. The use of multiple research instruments allows for the triangulation of data from multiple perspectives, increasing the validity of the findings [30].

Our research is being conducted in two flexible classroom spaces currently available at the University of Michigan. Classroom A (Figure 2) has a seating capacity of 48 students and is equipped with movable whiteboards and wall-mounted monitors located on the periphery of the room. These monitors can be connected to the instructor’s computer (both wired or wirelessly), students’ laptops, or a desktop computer located beneath each monitor which is connected to the College of Engineering computer network. Classroom A is typically arranged into small groups of some form, but instructors often rearrange the room into different layouts (Figure 3). Classroom B (Figure 4) has a seating capacity of 90 students and is also equipped with moveable whiteboards and wall-mounted monitors. Unlike Classroom A, Classroom B does not have desktop computers beneath each monitor. Classroom B is typically arranged into front-facing rows, but some instructors rearrange the room into small groups.

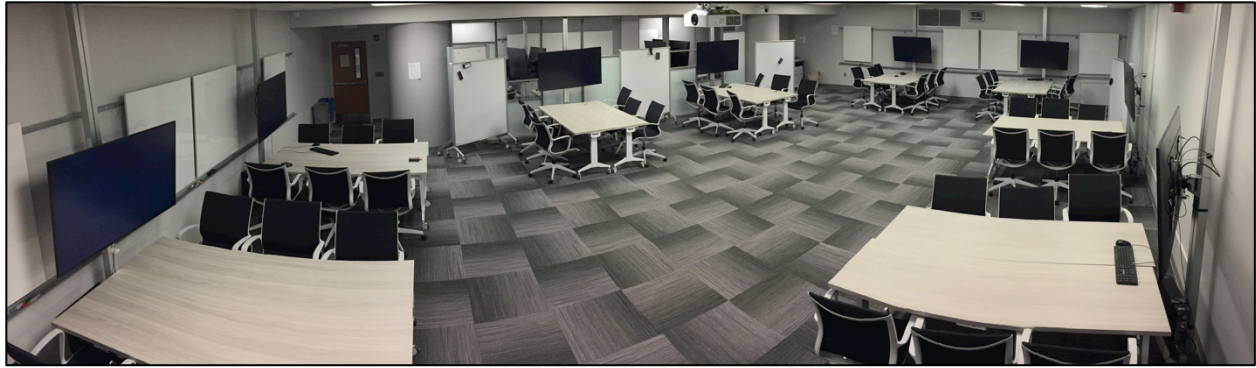


Figure 2. Panoramic photo of Classroom A arranged for a studio class.

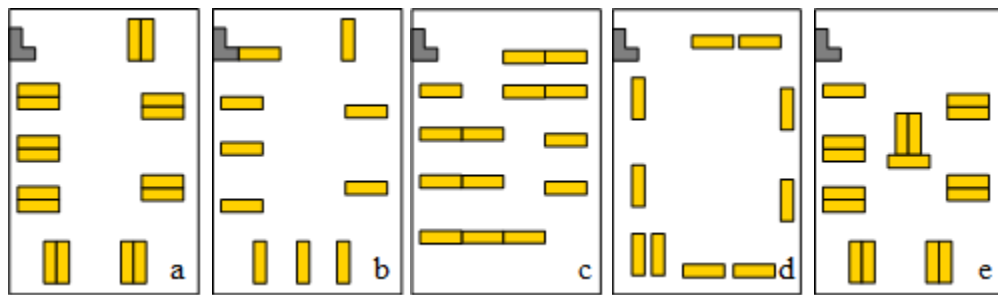


Figure 3. Classroom A set up for (a) small groups using double tables, (b) small groups using single tables, (c) lecture, (d) project demonstrations, and (e) project presentations. Each yellow rectangle represents 1 table that can seat 3 students per side.

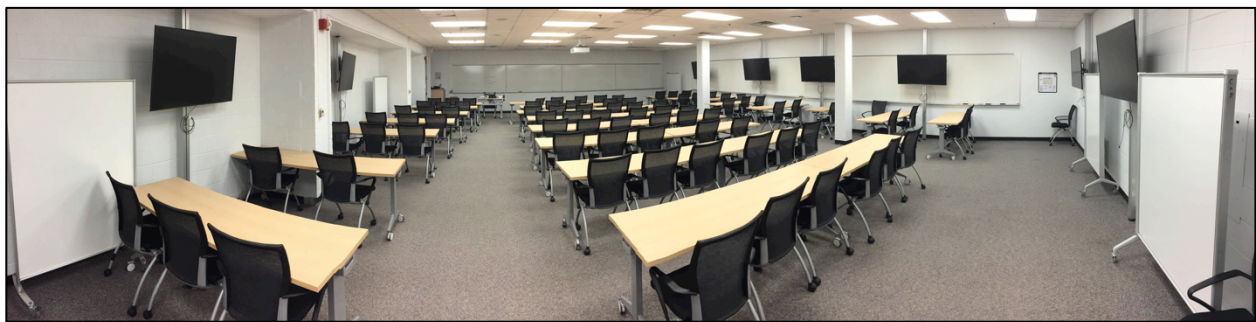


Figure 4. Panoramic photo of Classroom B arranged for lecture.

We are planning to follow five instructors as they teach the same (or a similar) second- or third-year engineering science course during two consecutive academic years. These instructors will be recruited from among those teaching large, introductory engineering courses based on: 1) their willingness to learn more about the flexible classroom, 2) their demonstrated use of student-centered teaching and regular incorporation of group learning activities, 3) their commitment to engage over the duration of the project, and 4) their expected teaching schedule. Each instructor will teach their course first in a traditional lecture hall and then, after participating in professional development focused on the affordances of the room, in a flexible

classroom. The professional development will consist of a half-day pre-semester workshop during the summer between the two academic years and a monthly faculty learning community [31] during the second year.

Instrument Development

Interview Protocol

We will interview each instructor twice during a semester—once at the beginning of the semester and once at the end. Each interview follows a semi-structured format, with a base set of questions serving as a guide. The questions in the pre-semester interview address six topics: 1) the instructor's background with the course and the evolution of the course, 2) the instructor's goals for his/her students, 3) how the instructor implements active learning, 4) how the instructor engages in formative assessment, 5) the instructor's participation in professional development, and 6) the classroom features that the instructor likes and does not like. The questions in the post-semester interview address similar topics, asking instructors if they felt students achieved the desired goals and asking for the instructor's perspective about specific instances of active learning and formative assessment that the researchers noticed in the classroom observations. The post-semester interview also asks the instructor's opinion of the classroom space and asks how they would use the same space differently in the future.

Observation Protocol

Our observation protocol has two distinct components to measure how the two aspects of pedagogy in which we are interested (the learning activities and formative assessment methods) differ between a traditional lecture hall and a flexible classroom. The first component, which is a modified version of the Teaching Dimensions Observation Protocol [32], documents the instructor's pedagogy in two-minute increments. The observer records the behaviors of the instructor and students and the technology used by each.

The second component of the observation protocol captures the details of each instance of formative assessment. Specifically, the observer records information about the instructor's initiation of formative assessment, the student's response to the assessment, and the instructor's response to students. Because student and instructor behaviors are specific to the type of formative assessment, the observation protocol incorporates different coding schemes for each type of assessment. More details about the observation protocol can be found in our companion paper [33].

Student Survey

To investigate students' perspectives of courses taught in flexible classrooms, we designed a survey to measure students' views of the instructor, their thoughts about the flexible classroom, and their personal role in learning activities. Many of the questions were taken from the Student Responses to Instructional Practices (StRIP) Survey [34] and the University of Minnesota Office

of Information Technology’s Student Survey for active learning classrooms (UMN OIT) [35]. We modified or added questions based on the classroom observations made during our initial work. The survey is designed to be administered twice during a semester, once near the beginning of the semester and once at the end. The beginning-of-semester survey only includes one set of questions, and the end-of-semester survey repeats those questions and includes four more sections. Table 1 lists each survey section and the relationships within the conceptual model (Figure 1) that are explored by that particular section. The table also outlines the source of the questions in each section.

Table 1. Survey sections capture students’ individual characteristics and perception of different relationships within the conceptual model.

Survey Section	Relationships Explored	Source of Questions
Types of Instruction	Student perception of pedagogy Individual characteristics of student	StRIP ¹
Instructor Strategies for Using In-Class Activities	Student perception of pedagogy	StRIP + Added questions
Student Responses to Instruction	Student response to pedagogy Inferring student’s framing	StRIP + Added questions
Student Thoughts about the Classroom	Inferring student’s framing	UMN OIT ² – Removed questions
Course Evaluation	Individual characteristics of student	StRIP

Types of Instruction consists of 16 questions. While the questions are the same in the beginning- and end-of-semester surveys, the context differs. At the beginning of the semester students are asked how often they expected to experience each of the type of instruction before the start of the semester, and how much they currently expect to experience each type. At the end of the semester, students are asked how much of each type of instruction they experienced throughout the course, and how often they would like to experience each type in their ideal course. Collecting students’ reports of the extent to which they experienced certain learning activities will allow us to triangulate with the classroom observations and instructor interviews. Understanding students’ ideal course will provide information about their individual

¹ The Student Responses to Instructional Practices (StRIP) Survey [34]

² The University of Minnesota Office of Information Technology’s Student Survey for active learning classrooms (UMN OIT) [35]

characteristics, which are important variables that influence students' responses to instruction and framing of learning activities.

Instructor Strategies for Using In-Class Activities consists of 14 questions about how the instructor facilitated and recapped in-class activities. We added additional questions to the StRIP survey [34] to explore the relationship between the instructor and student in more depth and capture one-on-one interactions, which we have found to occur more frequently in flexible classrooms. As with Types of Instruction, students' responses on this section will triangulate classroom observations and instructor interviews. An example of an added question is:

In this course, when the instructor asked you to do an in-class activity (e.g., solve problems in a group during class or discuss concepts with classmates), how often did the instructor answer questions one-on-one with individual students during the activities?

Student Responses to Instruction consists of 31 questions that ask students about different ways they responded to in-class activities. This section addresses the relationship between the instructor and student by showing students' responses to the instructor's pedagogy. As such, it also triangulates classroom observations and instructor interviews. Questions from the StRIP survey focus on four factors: value, positivity, participation, and distraction. We added questions that focus specifically on students' framing of in-class activities and interaction with each other. An example of an added question, which allows us to understand more about students' framing of in-class activities, is:

In this course, when the instructor asked you to do in-class, non-lecture activities, how often did you react by wanting to understand "why" instead of just getting the right answer?

Student Thoughts about the Classroom consists of 14 questions that aim to capture how the students perceived the classroom setting and explore the impact of the flexible classroom's affordances on how they frame the learning activities. The questions were selected from the University of Minnesota Office of Information Technology's Student Survey for active learning classrooms [35]. Because this survey was designed for a broad spectrum of courses, we removed questions that asked how the classroom influenced behaviors that were not expected to occur in undergraduate engineering science courses (such as developing confidence in writing).

Course Evaluation is a short four-question section. The questions are posed to capture students' opinion of the course overall. Students are asked to respond to questions based on a scale of agreement. This information helps to further understand individual characteristics of students.

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Future Work

We are continuing to develop the observation protocol by testing both components in the classroom. In Winter 2017 we used a modified version of the Teaching Dimensions Observation Protocol [32] to observe seven courses in Classroom A (Figure 2) during the winter 2017 semester. In Winter 2018 we used an initial version of the second component of the observation protocol to record instances of formative assessment in two engineering science courses in traditional classrooms. We are continuing to develop the classroom survey by conducting cognitive interviews with small focus groups of students. The focus groups will work through each section of the survey and discuss their interpretation of the questions with a pair of researchers. This will allow us to ensure that students are thinking about the questions in the way that we intended, and it will give us the opportunity to revise any questions that students commonly misinterpret.

The results of our study will provide evidence-based recommendations for classroom design, specifically focused on the instructional and framing affordances of a classroom that positively influence teaching and learning. These recommendations will allow faculty, classroom designers, researchers, and college administrators to advocate for and design flexible classroom spaces at their own universities.

We will also develop guidelines for professional development focused on flexible classrooms. Our initial work has shown that professional development is critical for helping faculty to fully take advantage of the affordances of a flexible classroom. Many instructors implemented new activities in the classroom but only after spending a few weeks in the room and getting a feel for its affordances. Furthermore, relatively few instructors rearranged the room into a layout that best suited the activities they had planned; instead, most just taught in the layout left from the previous class. To help overcome these challenges, we have held professional development meetings in which instructors who will be teaching in a flexible classroom share their pedagogy, hear advice on what worked for other instructors, and discuss possible learning activities and classroom layouts. As the project continues, we will hold more formal professional development

with instructors through a half-day summer workshop and a monthly faculty learning community. From these experiences we will develop evidence-based professional development guidelines to support faculty and staff at other universities who also create flexible classrooms.

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