

Out-of-Class Impacts of Flexible Classroom Spaces

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Out-of-Class Impacts of Flexible Classrooms

Abstract

This student-led research project analyzes the impact that the conversion of a computer lab to a flexible classroom space had on informal use of the space outside of class time. Studies have been conducted on the benefits of informal learning settings, but there are few studies on how the physical space itself can support the informal learning process. Research surrounding learning spaces in libraries has emphasized use of collaboration and flexible spaces, but these studies have been conducted to inform space design decisions rather than assess the impact of those design decisions. This study investigates the unintended benefits of a new flexible classroom through a post-occupancy space analysis.

Introduction

Student learning takes place both in class and out of class. Student collaboration in study groups, student design teams, and group projects often takes place outside of formal lecture and inside the realm of *informal learning*. Engineering students spend a significant amount of time working in groups for homework, class projects, design groups, and competitive student project teams (e.g. solar car, Mars rover, human powered submarine, etc.). Collaboration requires space to meet and resources to support meetings, but space is often in short supply on university campuses. As a result, many spaces are utilized for multiple purposes, and classrooms are often used outside of class time. When not in use, classrooms can host student organization events, project team meetings, and students simply doing homework.

The increase in student centered pedagogies has encouraged universities to renovate traditional lecture style classrooms to studio or flexible classrooms [1]. Increases in the number of flexible and studio classrooms raise the question of how universities can design these spaces to also support student informal learning beyond their intended use as classrooms.

Studies have been conducted on the benefits of informal learning settings, but there are few studies on how the physical space itself can support the informal learning process. Research surrounding learning spaces in libraries has emphasized use of collaboration and flexible spaces, but these studies have been conducted to inform space design decisions rather than to assess the impact of those design decisions [2]. This study aims to fill the gap by investigating the unintended benefits of a new flexible classroom through a post-occupancy space analysis.

Background

The way a space is designed is often reflected by its primary usage. Certain aspects of a learning space, including formal spaces like classrooms and informal spaces like study rooms, include features that indicate that a room should be used in a certain way. These features are often referred to as *affordances* and define the intended purpose of a room [3]. In engineering education, specific affordances are often built into a classroom to encourage beneficial learning practices both in and out of the classroom.

There has been an increase in considerations for the design of informal learning spaces at universities [4]. Designs often include conscious decisions to encourage student collaboration and may feature reconfigurable furniture, increased white board spaces, and comfortable seating.

Concurrently, there has also been an increase in the development of studio or flexible classrooms at universities across the United States. Studio classrooms have seating that is permanently arranged in group style seating, designed to facilitate group work [5]. A similar yet distinct classroom style is the flexible classroom. Flexible classrooms are rooms that allow for studio seating, but in which the furniture arrangement is not permanent, and tables and chairs can be easily arranged. As a result, instructors can rearrange the room into front-facing rows for lecture or into small groups for active learning. Flexible classrooms can include other features such as group-sized monitors and rolling whiteboards that also afford collaboration, similar to the features of informal learning spaces [6], [7].

Multiple studies have been conducted on how the affordances of a physical learning space are used by the occupants. Research about studio-style classrooms has shown that group seating can increase meaningful interaction between students and facilitates group activities during class time [5]. Research about the use of informal learning spaces has also been conducted [2], but that work was used to inform design decisions rather than assess the impact of the design .

This study examines the decision a large public research university in the Midwest made to convert multiple spaces to flexible classrooms to support active learning and other student-centered pedagogies. We have previously studied the in-class usage of the flexible classrooms [8], and here we expand the original study to understand how flexible classrooms are used by students out of class.

Creation of the Flexible Classroom

The room we explore is in a laboratory building and was originally configured as a computer lab to teach Mechanical Engineering classes. After the main Mechanical Engineering building on campus was renovated, classes were moved back to the main building, leaving the room unused. Student design teams took advantage of the now-unused space and computers due to its proximity to the student team project center. Prior to the conversion of this computer lab into a flexible classroom, student engineering design teams mainly used the room for individual Computer Aided Design work. The room consisted of a traditional computer lab design with tightly-packed tables of computers. The tables were shaped like traditional rectangular tables, but with rounded edges with computers on both sides so that users faced inward. **Figure 1** shows a photograph of the original design of the room.



Figure 1: Original layout of the classroom featured in study

A focus group with members of student design teams gave insight on how their teams used the original computer lab. One student explained:

Before the renovation I believe there were 24 computing stations in the room, and they were set up in clusters. Every night during the weekend, basically all weekend, the computers were almost full. So they were packed with students that were using them for their engineering projects. They were using them to work on computer aided design, to work on FEA [Finite Element Analysis], to work on CFD [Computational Fluid Dynamics], to work on any sort of engineering analysis or design work they needed to do that they needed [engineering resources] for.

The students in the focus group indicated that the computer lab was used both for individual work and collaborative work. Students also noted that collaborative work was inhibited by the layout of the room, reporting “it got cramped, crowded around certain computers when you did want to do collaborative work.”

The new flexible classroom design is shown in **Figure 2**, design motivations included the desire to be able to use the room to accommodate both lecture and active learning pedagogies. The new design includes more open space with tables on wheels that creates the flexibility to configure the classroom in front-facing rows or group seating that promotes increased interaction.



Figure 2: Renovated layout of classroom

The new layout features affordances that facilitate collaboration, such as reconfigurable furniture, moveable whiteboards, and monitors around the perimeter of the space which can be connected to a desktop computer on the College of Engineering network or a personal laptop. The classroom is typically arranged with tables in small groups like a studio classroom, but the rolling furniture allows it to be arranged into any layout as shown in **Figure 3**. The room is designed for a capacity of 48 people. The layout on the left is the typical layout of the room used for most classes held in the room.

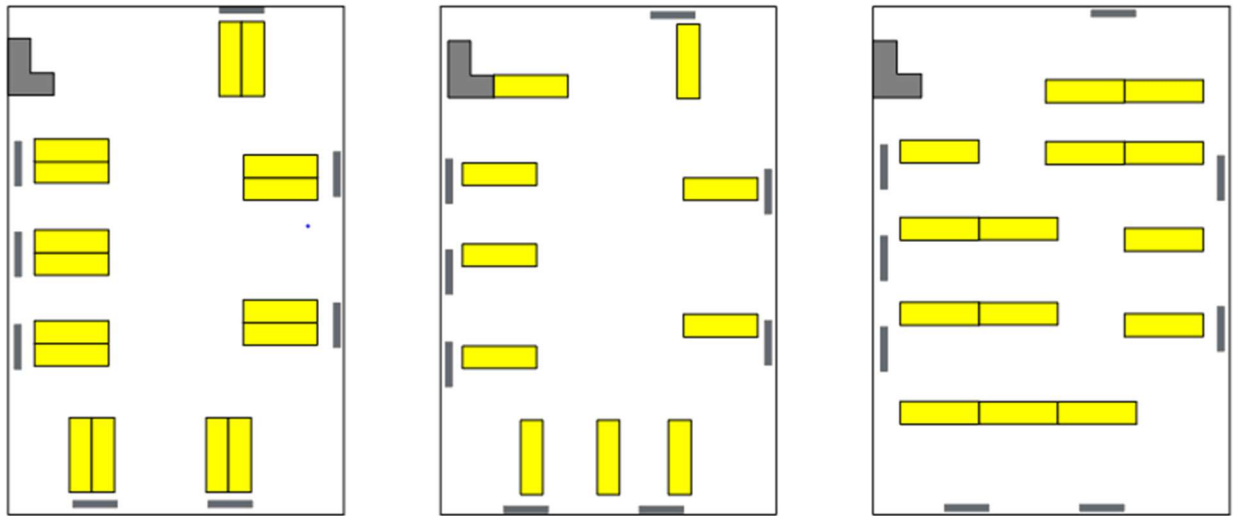


Figure 3: Possible layouts of moveable tables

Within this study, we explore the impact of converting a space from a computer lab to a flexible classroom by looking beyond the intended purpose of a classroom. Within this exploration we ask three research questions: 1) How was the room used outside of classes? 2) During out of class usage, how were the classroom affordances used? 3) How has the change from a computer lab to a flexible classroom impacted those who used it before the renovation?

Methods

We answer the first two research questions using data from observations of the classroom after renovations, and we answer the third research question using data from a focus group with student project team members.

Observations

To study usage of the space, we observed the classroom for one full week near the end of the semester. Specifically, we recorded, without the use of video or audio recording to ensure student anonymity, the number people in the room; the duration each person was in the room; the use of the room; and what affordances, if any, the person or group took advantage of. In order to capture data both during the day and after class, we observed the room from 9am to midnight (use of the room often continued beyond midnight, but this was not recorded or included in this study.) We previously presented data about the in-class use of the space [9], and here, we present the out of class data.

The number of people in the room was recorded by person-hours (i.e. the sum of the time spent in the room by all people). The number of people in a room was summed every half hour to evaluate when the room was being used and how often the room was used. People who were in the room for less than five minutes were not recorded for the study. For the week observed, the maximum number of people using the room outside of class at a time was 32 people.

How a person used a room was coded into one of five categories, determined post hoc: *Early for Class*, *Alone*, *Group*, *Attending Office Hours*, and *Department Activity*. *Early for Class* was used

to define a person who arrived at least 15 minutes before the start of a class and stayed for this class. This criterion distinguished those who purposely came early to use the classroom from those who arrived early due to bus schedules and the university's ten-minute class transition time. *Alone* was used for a person who used the space individually and did not partake in any collaboration. *Group* was used for people who either sat in a group or partook in collaboration within the room. Some faculty and lecturers chose to use the room for out of class support, and students who took advantage of that time were recorded as using the room for *Attending Office Hours*. The *Department Activity* category was added the classroom was used for a department information session for parents and potential students for a significant period during one observed day.

The affordances used were recorded during observations. We recorded the affordances used during our observations (e.g., rolling whiteboards, monitors with a College of Engineering desktop connection, monitors with a personal laptop connection, whiteboards), as well as other technology (e.g., personal laptops, phones, etc.) a. This usage was summed for each thirty-minute interval. Rearranging of furniture was recorded by sketching diagrams of the room layout.

Focus Group

We conducted a focus group with six students from four different student design teams. Students from the University's project teams were recruited by email for this focus group because of their use of the flexible classroom both before and after renovations. The focus group included prompts about how the room was used before, how is it used now, and if the student take advantage of the affordances in the room. The focus group was recorded, transcribed, then reviewed and edited to correct miss-transcription.

Data Analysis

To answer research question 1 (*How was the room used aside from classes?*) we recorded usage of the room as the five groups referenced in the previous section: *Early for Class*, *Alone*, *Group*, *Attending Office Hours*, and *Department Activity*. The total usage of the room for the week is included in **Table 1**.

Table 1: Total usage of room for observation week in person-hours

Early for Class	Alone	Group	Office Hours	Department Activity
23	136	555	63	48
Total				825

In **Figure 4**, the use of the room is broken down by half hour sections for two days, Friday and Saturday. These two days were selected to show both a weekday and a weekend-day as well as how each usage of the room. Friday was selected as it was the day with the largest usage for office hours, and the room was only used for classes from 9:30-11:00 am giving more opportunity to be used outside of class. Despite being a Friday, the proximity to finals meant the

room was still used late into the night. Saturday was chosen to represent weekend usage as it shows an atypical use of a classroom, a department activity. In addition, the Saturday figure shows a large usage of the room late into the day. Notice that during both office hours and the department activity, students still utilized the room for individual and group work.

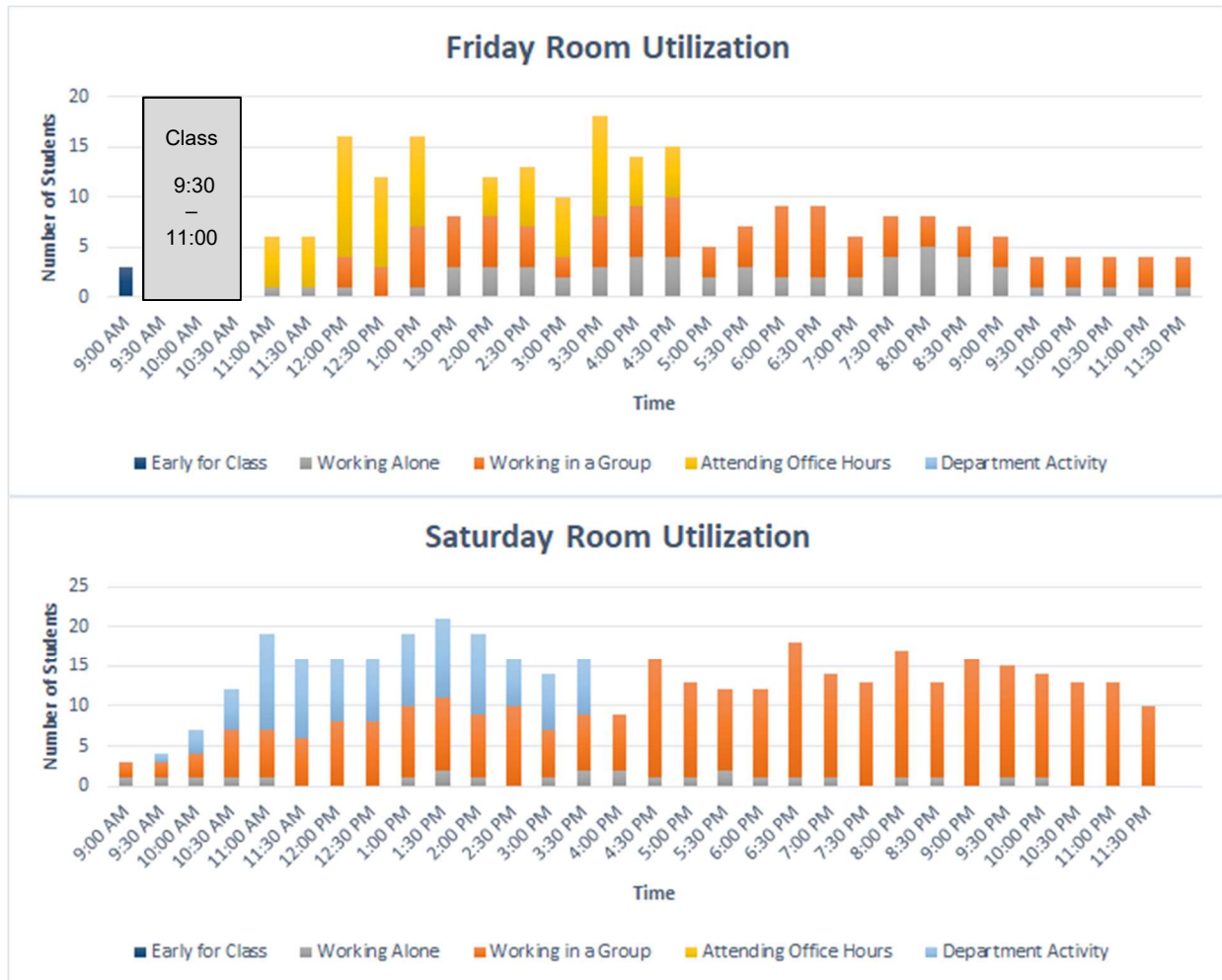


Figure 4: Room usage during observed hours

To see how the room is used collaboratively, the two categories *Alone* and *Group* were isolated. These two groups were the largest users of the room for the observed week. For the week observed, collaborative group work was the largest use of the room, with a total of 555 person-hours (67.3% of total person-hours). Individual work, or *Alone*, was only totaled 136 person-hours for the week (16.5%).

The observations were also used to answer research question 2 (*During out of class usage, how are the classroom affordances used?*). We observed users of the room re-arranging the tables and chairs to accommodate groups, and using the moveable whiteboards, large computer monitors, and their own personal technology like laptops. Two sample layouts that students created in the classroom are included in **Figure 5**.

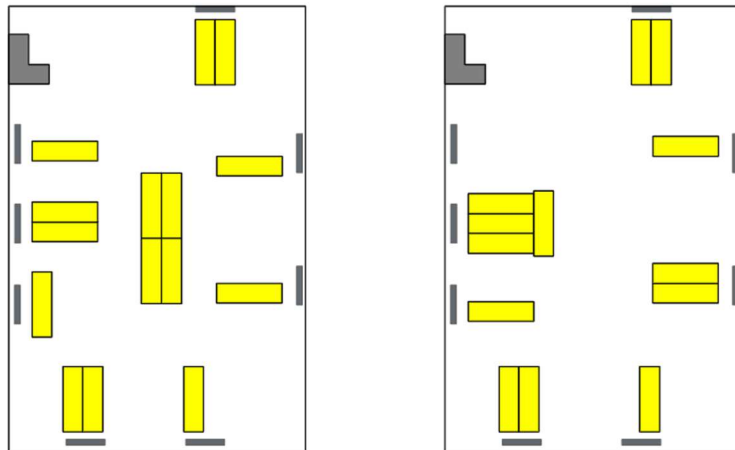


Figure 5: Layouts for department activity (left) and student group meeting (right)

The two layouts shown align with two different group uses of the room. One is the arrangement of the room from the department activity where students moved four tables to center of the room for the event. The other layout was during collaborative group work by students who arranged a group of four tables around a monitor to support their meeting.

In addition to observing users rearrange the tables and chairs, we recorded usage of the moveable whiteboards, personal laptops, and the large computer monitors. Different students used these affordances in different ways. For example, some people utilized the whiteboards to make a physical barrier to separate the room. Others used it in a more traditional way as a surface for temporary writing. **Table 2** shows the total usage of technology and affordances in the room in person-hours, and its data shows significant usage of affordances.

Table 2: Total usage of affordances for the week observed in person-hours

Personal Laptop	Monitor with Laptop Connection	Monitor with Desktop Connection	Whiteboard	Other (phone, notebook/paper, etc.)
249	151	49	27	62
Total				538

Of the affordances observed, the use of the monitors, connected either to the personal laptop or to the desktop and the whiteboards were affordances specific to the design of the room. Over the course of the week, the room's affordances were used of 27.5% of the time observed.

To answer research question 3 (*How has the change from a computer lab to a flexible classroom impacted those who used it before the renovation?*), we summarize common themes from the focus group about how student project teams now use the flexible classroom. When asked about the affordances in the rooms, the team members felt that while the College of Engineering desktop computers in the classroom featured the same programs that they used before the

renovations, the layout of the room no longer supported “engineering.” We interpret this stated definition of engineering to focus on using computer-aided drafting (CAD), finite element analysis (FEA), and computational fluid dynamics (CFD) programs that these students used in the previous computer lab.

Instead of “engineering,” team members used the flexible classroom for different tasks. One student said, “those computers actually just get used for homework because they have a lot of table space. I will use it when I’m doing homework.” Another student elaborated:

You can go you can look at a spreadsheet. You can look at a timeline. You can look at a web page but straining your neck and trying to work like this on a screen that's four times the size of what you need, and the aspect ratio is entirely off is ineffective. So we do not use it for any engineering at all.

One affordance that was viewed as a positive addition to the space was the whiteboards. The whiteboards helped communication between project team members. In one section of the interview, multiple students commented on the whiteboards.

Student 1: “The whiteboards are nice.”

Researcher: “So you guys use the whiteboards to ...?”

Student 2: “I have used the whiteboards actually.”

Researcher: “Is it for working on stuff by yourself or working on stuff collaboratively or...”

Student 3: “Explaining stuff.”

The students explained that the room’s affordances were most often used by project team students and other engineering students for homework, shifting away from its former use as a computer space for the project teams. Although the space is still used by the teams, the project team work done in the room is what they described as “high level” and less of the computer program based “engineering”.

Discussion

The affordances of the flexible classroom provided the opportunity for more groups to take advantage of the space in both traditional and less obvious ways a. While we assumed students would use the space, we found that other groups on campus, like academic departments and professors, also took advantage of the space.

We assumed that the large table space would attract students for work outside of class, and students would take advantage of the space if they were early for class. This assumption was confirmed as students using the room as a work space, alone and in a group, were the two largest uses of the room throughout the week. The change in room layout allowed it to be used for a larger variety of work by still housing computers, but with more table space, flexibility, and resources like whiteboards. This allows the room to be utilized by a broader range of students.

The use of the room by students was mainly collaborative. Student group work was four times more common than working alone for the week observed. This is consistent with the intended

design of the room. The technology in the room and flexible design were intended to facilitate group work in class, and the room affords the same collaboration out-of-class as it does in class. As shown in **Figure 5**, students took advantage of the flexible affordance of the classroom to move tables to accommodate different group sizes. In addition to the flexible furniture, the other technologies and affordances saw consistent usage throughout the week.

The less obvious uses of the room, office hours and department activities, show the broad scope of how the room can be used. The movable furniture and large open room support multiple room layouts and therefore multiple types of events. The department activity that took place on the Saturday could not have been held in a computer lab and would be more difficult in a standard classroom. The event benefitted by being able to easily move the furniture to the altered arrangement shown in **Figure 5**. Events like this increase the use of a classroom on weekends, when it is not used for its intended activities. Observing these less obvious events suggest that there are more potential uses for the room that were not covered in this study.

With all these positive benefits of the flexible classroom, the student project team members who participated in the focus group still had a negative opinion of the redesign, as the classroom was no longer suited for “engineering.” They were dissatisfied as they had to relocate to other spots on campus to do work with engineering software and CAD. We believe this occurred because when the College of Engineering decided to renovate the room, they did so with the intention of creating a new classroom. As a result, design decisions were made to satisfy the stakeholders—the instructors and students who would use the room for class. Before the renovations the student project teams self-identified as the primary users of the space, but they were just occupying a room that was temporarily unoccupied by classes. Despite believing themselves to be stakeholders, the student project teams were not considered to be stakeholders in the redesign. While this is certainly a justifiable design decision, we believe the experiences of the student project teams emphasize the importance of clearly communicating information about the affordances of a flexible classroom and the justification for their inclusion in the classroom. This information is valuable to instructors who use teach in the room, and it would also be valuable for students who used the room in the past or who may want to starting using the room now that it better supports collaboration.

Conclusions

The transition of traditional classrooms into flexible classrooms allows for flexibility in both their in-class and out-of-class uses. The flexible design and the affordances integrated into the room can be used by multiple groups within a university. The multi-use space helps overcome the scarcity of space often faced by universities, as the flexible classroom can be used by students, student groups, faculty, departments, and many others. These spaces also help fill the need for more informal learning spaces and collaborative work spaces on campus. The ability for group style seating, moveable whiteboards, and large monitors lend themselves to collaborative group work and can support the increasing collaboration in engineering education. When given the opportunity, students took advantage of the space and its affordances showing the out-of-class impacts of the flexible classrooms.

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