During the spring and summer of 2016, Teaching and Learning with Technology (TLT) undertook the renovation of the classroom space in 101 Althouse Laboratory. Branded the “Bluebox,” the space was completed by the fall semester and utilized by faculty and students during Fall 2016 and Spring 2017. During the academic year, TLT researchers collected data both to provide information to university stakeholders about classroom utilization and to document and highlight the kinds of teaching and learning experiences that took place in the space. This document reports on both for the purpose of informing ongoing learning space design and faculty development.

Report on the Bluebox Classroom in 101 Althouse Lab

Submitted June 2017 by Crystal Ramsay, PhD, with research and report preparation support from Xiuyan Guo, Bart Pursel, and Gi Woong Choi
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The Bluebox

The Bluebox is located on the first floor of Althouse Laboratory, situated in the central part of Penn State’s University Park Campus. Althouse Laboratory is the academic home of the Biochemistry and Molecular Biology department in the College of Science. Prior to the renovation, the maximum occupancy in 101 Althouse was 110. The seating capacity of the new Bluebox is 44. See Figure 1 for pre- and post renovation photos.

![Figure 1. 101 Althouse Laboratory, pre-and post-renovation](image)

The Bluebox is, in the current vernacular of learning spaces, an Active Learning Classroom (ALC) (Baepler, et al., 2016). As such, it is characterized by a flexible layout, multi-height seating, an interactive display, writeable walls, wireless projection, a changeable Unistrut ceiling, and multi-access power. Although the space is housed within a BMB-focused (Biology) building, utilization of the classroom is discipline-agnostic: Faculty from any discipline may teach in the space, as long as their pedagogical goals align with the active learning and collaborative nature of the classroom design. The space was constructed to be sufficiently flexible to enable faculty to be flexible in their pedagogical approaches. See Table 1 for 2016-17 occupancy details.
Table 1
Bluebox occupancy details

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</table>

During the 2016-17 academic year, the Bluebox was host to 22 unique instructors and 458 students enrolled in 18 unique courses (undergraduate and graduate) representing five colleges. One faculty team taught both in the fall and in the spring. Others from Fall 2016 will teach in the Bluebox when their course is offered again during the Fall 2017 semester.

Faculty Development and Support

Face-to-face contact
Instructors teaching in the Bluebox received support in a number of ways. Onboarding activities included:

- A meeting in the Bluebox with either the learning spaces coordinator or the learning spaces manager – This meeting was an opportunity for faculty to see the space and for learning spaces staff to diagnose the relative match between instructor pedagogies and the affordances of the classroom space.
- A “Tech Tour” of the space as a cohort prior to the semester – This meeting was facilitated by TLT personnel including classroom technologies staff, the learning spaces coordinator, the learning spaces manager, and members of TLT’s Faculty Programs group which includes education researchers. The tour served as an opportunity for the faculty to get to know one another and to learn about “what’s possible” as they planned for teaching in the space.
- An open “sandbox” time when faculty were invited to the Bluebox to try out specific instructional ideas; practice opening the Solstice software and loading and manipulating content; explore furniture configurations they might like to employ; and ask questions before the semester.

Support during the semester sometimes intersected with TLT’s research investigations.
- Re-captures & check-ins – The faculty cohort was convened twice during each semester to discuss Re-Captures (see below) and to generally check in about how things were going.
- The TLT learning spaces team was available as needed to consult with faculty.

Faculty-facing website
A faculty-facing website was created within the Sites blog platform to share information and resources with Bluebox faculty:
https://sites.psu.edu/althousebluebox/

The site includes five tabs: (1) the Home tab addresses basic information about the Bluebox, including when it is occupied as well as whom to contact with issues/concerns; (2) the Getting Started tab provides detailed instructions for logging into Solstice and navigating the display wall as well as suggests syllabus language and a first-day-of-class activity to introduce students to the technology; (3) an FAQs page provides a list of, primarily technical, questions with answers and solutions to common issues that arise; (4) a Resources tab includes guides and suggestions related to active learning; and (5) a Research tab which currently includes published research on learning spaces, but which will eventually include Penn State research.

Cohort approach
There were two times during each semester when it made sense to convene the Bluebox faculty as a cohort. First, prior to each semester, all new faculty were invited to a “Bluebox Tech” tour. During this tour, all the amenities of the classroom space were described, especially how to use the large display wall, in conjunction with the Mersive Solstice software. Faculty were challenged to begin thinking and sharing how they planned to use the space. Second, the Re-Capture approach included faculty conversations around space configurations that were effective, or not, in helping to achieve instructional and learning goals. Informal feedback from faculty suggested they appreciated opportunities to learn from one another. The learning spaces team anecdotally noted that an organic respect for the space and for one another seemed to emerge from the cohort approach.

Research Methods and Findings

Data Collection Methods
A variety of data collection methods were designed and leveraged to collect information from both students and faculty. The multi-pronged approach allowed for data triangulation to inform the dual purpose of the research: to inform facilities utilization and to report on teaching and learning implications.
Faculty Data Sources

Data were collected from Bluebox faculty by four methods. Two were typical approaches: Pre- and post-surveys and direct classroom observations. Both of these data collection methods focused primarily on room usage and satisfaction. Two others were novel approaches designed to target specific research questions: Flashbacks and Re-Captures, which centered around instructors’ experiences teaching in the space.

Pre- and post-surveys. A pre-course survey queried the faculty on their Technological Pedagogical Content Knowledge (TPACK) (Mishra & Koehler, 2006) and their instructional approaches, particularly with respect to the course they were teaching in the Bluebox. (See Appendix A for the full survey instruments.) Seventeen faculty members completed the pre-course survey, and 12 completed the post-course survey. More than half (59%) of respondents had taught the particular course more than three times before, and only two faculty members indicated that this was their first time teaching the course. Most faculty (82%) reported that when they previously taught the course, they took class time to move furniture around to accommodate different learning activities. Moreover, they reported the layout of the traditional rooms and furniture made it either difficult to use or discouraged them from using particular teaching techniques. Among the 12 faculty members who responded to the post course survey, nine (75%) indicated they would recommend teaching in the Bluebox classroom to a colleague, two of them selected “Maybe”, and one selected “No.”

One question which appeared on both the pre- and post-surveys asked faculty how they allocate time to particular instructional approaches across a semester. There are some limitations of a question like this; but given data triangulation, the question was nonetheless included. Results indicated no meaningful change in distribution of approaches when transitioning from a traditional classroom to the Bluebox. Results from this question mainly confirmed that we need more nuanced, non-self-report instructional comparisons, as findings from other data sources suggest there was change. Better ways of detecting and measuring that change must be leveraged in future research.

Koehler and Mishra’s (2000) TPACK framework was leveraged to inform development of 16 survey items. Given relatively low numbers of Bluebox faculty as well at TPACK’s original focus in K-12 education, there was no attempt to generate scales nor formally validate the measure. Nonetheless, the framework was useful as a guide to assist in development of items to broadly survey instructors’ knowledge and efficacy at the nexus of technology, pedagogy, and content. Table 2 reports on faculty TPACK efficacy, reported at the group level, both pre- and post-semester.

<table>
<thead>
<tr>
<th>I know how to assess student performance in a classroom.</th>
<th>Strongly agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Strongly disagree</th>
</tr>
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<tr>
<td>post</td>
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</tr>
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</table>

Table 2

Group-level frequencies of TPACK-inspired efficacy items
| I can adapt my teaching based upon what students currently understand or do not understand. | 11 | 10 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| I can adapt my teaching style to different learners. | 5 | 3 | 8 | 8 | 0 | 1 | 1 | 0 | 0 | 0 |
| I can assess student learning in multiple ways. | 7 | 9 | 6 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| I can use a wide range of teaching approaches in a classroom setting. | 4 | 6 | 10 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| I am familiar with common student understandings and misconceptions. | 7 | 4 | 6 | 8 | 1 | 0 | 0 | 0 | 0 | 0 |
| I know how to organize and maintain classroom management. | 8 | 6 | 5 | 6 | 1 | 0 | 0 | 0 | 0 | 0 |
| I know about technologies that I can use for understanding and doing my discipline (e.g., Chemistry, GIS, History). | 4 | 7 | 7 | 5 | 2 | 0 | 1 | 0 | 0 | 0 |
| I can choose technologies that enhance the teaching approaches for a lesson. | 4 | 5 | 7 | 6 | 2 | 1 | 1 | 0 | 0 | 0 |
| I can choose technologies that enhance students' learning for a lesson. | 3 | 4 | 6 | 7 | 3 | 1 | 1 | 0 | 0 | 0 |
| I can think critically about how to use technology in my classroom. | 6 | 11 | 7 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| I can adapt the use of the Bluebox technologies to different teaching activities. | 5 | 5 | 6 | 6 | 2 | 1 | 0 | 0 | 1 | 0 |
| I can teach lessons that appropriately combine my discipline, technologies, and teaching approaches. | 6 | 6 | 7 | 6 | 0 | 0 | 1 | 0 | 0 | 0 |
| I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn. | 5 | 5 | 7 | 6 | 1 | 1 | 0 | 0 | 1 | 0 |
| I can provide leadership in helping others in my department to coordinate the use of content, technologies, and teaching approaches. | 7 | 5 | 2 | 5 | 4 | 1 | 0 | 1 | 1 | 0 |
| I can choose technologies that enhance the content for a lesson. | 5 | 5 | 7 | 6 | 1 | 1 | 0 | 0 | 1 | 0 |
| Total score | 93 | 97 | 100 | 87 | 18 | 7 | 7 | 1 | 4 | 0 |
Descriptively, there was a 9% increase in “Strongly Agree” ratings at the group level from pre- to post- semester. This suggests that, by the end of the semester, faculty were feeling more confident teaching in the Bluebox, at least with respect to these items. Such an analysis, however, fails to capture responses at the middle of the range of options. So we calculated a total score for each respondent and looked at change in the average. The average total score at pre-test was 66.9; at posttest, it was 71.5. This represents a 4.6-point increase in average scores between the beginning and the end of the semester.

Open-ended questions in the post survey targeted specific aspects of the Bluebox space and its usefulness in meeting instructional needs.

Q1. How did the design of the Bluebox classroom impact your ability to engage your students during class?

**Movable seating**

- The modular furniture increased my ability to switch between small group discussions and full class discussions multiple times per class period.
- I like to encourage small group discussion and activities in class, so the moveable seating and small group orientation was most valuable to me.
- I really appreciated the seating flexibility,...It made it much easier to move from small groups to classroom discussions.
- The layout of the room and moveable furniture made group discussion much easier.

**White Boards**

- The white boards allowed students to diagram answers and analyze them after discussions.
- I really appreciated...having all the white board space. It made it much easier to move from small groups to classroom discussions.
- All the available writing surfaces really enhanced small group work. This was further enhanced by the modular seating.
- ...having ample whiteboard space was very helpful for me to be able to explain concepts without erasing anything, but students did not often write over these pieces, only pointed or referred to what I had already written.
- There was not much room to elaborate on the white boards in the front of the room.

**Display screen**

- My class had a heavy computing emphasis, the mobile power access was often useful.
- Although I had a strategy that worked for discussions based around clicker questions, I still prefer how that aspect worked in a more traditional room with a projector screen in one corner and a large blackboard I could use to discuss and demonstrate material related to the question. The clicker questions are meant to guide and
instigate discussion, but with the large central screen they became the perceived focus.”

• I enjoyed the teaching technology immensely, but as I noticed solstice available in many classrooms, I began to wonder if I was utilizing other parts of the room.

Configuration/atmosphere

• I was able to be more creative and interactive and engaged with students this semester.
• I very much enjoyed being able to sit down with small groups of students at individual tables, and to bring over a white board to explain concepts. This gave our small group activities a very nice, personalized feel.
• To build on a theme that was mentioned in reflections throughout the semester, the Bluebox made class a much more participatory endeavor. The furniture, the white boards, the Solstice display - their constant presence compelled you to think of how to best leverage them and classes where content was disseminated in a more traditional lecture format felt like a squandered opportunity to create engagement. Breaking students into small groups and giving them the tools to work through a prompt organically made it possible, not just for students to show their learning, but also for me as an instructor to chat with them about their thought processes, the ways they were approaching problems and the challenges there were encountering.
• A lot more engagement in this room compared to the old room I used, which were rows of tables with computers attached to them, and no whiteboards. We spent more time this semester doing small group activities, that involved brainstorming and problem-solving using the whiteboards. We also were able to use the display wall, and have students share content to the screen as part of activities. Much more engagement in this space. It also creates a more comfortable, casual environment for discussion. At least it seemed that way towards the end of the semester.
• The comfortable atmosphere enhanced student conversations with each other and with me (and the TA). It was nice to be able to move the furniture and seats to accommodate groups of different size.

Q2: Think about the types of learning activities or instructional approaches you most want to use with students. For which activities or approaches was the Bluebox space particularly well-suited? Not well-suited?

Well-suited: Group work, discussion, and presentation

• It was very well suited for group work and I loved having all the white board space…. We did a debate, lots of group work followed by discussions, and student presentations. Overall it was far better than a regular classroom.
• I like to encourage small group discussion and activities in class, so the moveable seating and small group orientation was most valuable to me.
• Great for student presentations and face-to-face discussions.
• Extremely well suited to small group discussions and think-pair-share type activities, as well as full class discussions. Presentations using the display are easier than with the projectors in standard rooms.
• I rely heavily upon small group work and student led presentations/discussions. The space was beautifully suited for this.
• Role plays, creativity, engagement, flexibility, active learning
• I try to make most class periods centered partially or completely around student discussion. I believe that the moveable furniture and marker board walls inspire creativity and active learning.

• The Bluebox spaces is well-suited to group activities that require brainstorming sessions. It is also well-suited to group brainstorming and collaboration. It was also handy for design-based activities.

• The Bluebox excelled at fostering a supportive environment for small group collaborative activities as well as content sharing and discussion. Even during traditional lectures, the differing seating heights made it easy to maintain eye contact with everyone in the class.

Not well-suited: Testing, class enrollments at room capacity, lecture

• My class enrollment was nearly capacity for the room, the soft chairs with limited table space were awkward for some students.

• The downside to having more tables was that it got a bit more cumbersome to rearrange the room.

• Paralleling the answer above: for small group work, the room was wonderful. For guided discussions where I wanted to combine technology with guided discussion, I thought it worked much less well. I was not able to give exams in the space, which was a bit of a hassle.

• While power is an affordance of the room, ironically its less effective when there are lots of computers out (or more specifically power cables). With a class near room capacity, moving around a room with lots of extra cables is (as you might expect) challenging. And though we never conducted any formal exams in the space, I don’t imagine it would be well suited for that purpose either.

• Small group activities it is well suited for, but with an enrollment of 45 students, it does become rather crowded. I found it hard for me to navigate around the room and visit with each team, as the room feels very cluttered when all the whiteboards are in use (wall + mobile).

• It is not particularly well suited for times when you need to lecture (it isn’t bad but the wall display is a bit clunky for a straight-up presentation). It is great for doing group problem-solving, case studies, discussions etc.”

Q3: What were the differences, if any, between the ways you are using the Bluebox and the ways you’ve used other spaces where you’ve taught this course/subject?

More flexible

• I really appreciated the seating flexibility, being able to display multiple files on the screen and having all the white board space. It made it much easier to move from small groups to classroom discussions. In normal classrooms we had limited blackboard space. I also had much more flexibility in the Bluebox room in how I put together materials to project during class.

• This semester, the way I have taught the class did not change, but it worked as I had always envisioned it should, in contrast to frequent problems in standard rooms.

• First time I had the flexibility to move around room and have students be able to readily interact with me and each other.
In the past, if I have ended up in a crowded and uncomfortable classroom, I have turned the group problem solving and discussion assignments into take-home assignments because it was too awkward to ask the students to work together during class time.

More Creative

- More creativity, thinking outside the box with lessons
- This is my first semester teaching IST 446, but I've sat in on previous versions of the course when it's been taught in a computer lab environment. The Althouse space was far better at supporting discussion, collaboration and movement. There was also no "hiding behind a screen". Having said that, students had to bring their own computers for more technical lectures, which encouraged us to keep the course more design focused.
- Bluebox allows me to be more flexible and creative in how I want to approach teaching specific topics each week.

Easier to get students involved

- Way easier to get students involved
- I allowed students to use technology in the classroom for the first time, and I also had students bring in examples to share through the Solstice app more often.
- In the past, I have not been able to allow students to cast their screen as easily and readily when they face impediments with software. Students were also more prepared to share resources with one another. Collaborative problem solving really enhanced the class understanding of not just routine analysis, but the types of real-world problems that occur when performing an analysis on your own data.
- In Bluebox I used the iPad to display questions and write some notes, which I could later post online. I think that was useful for students. The group work was much smoother since we didn't have to rearrange desks.”

Q4: How did the Bluebox and its amenities/affordances impact your role as a teacher?

Enhanced teaching

- It enhanced my teaching.
- It was enjoyable to teach and to plan activities for the Bluebox room.
- Greater interactions with students.
- Loved having the room and flexibility of space to teach; appreciated having Tim as a resource and the team to support and help me reflect more on my teaching as we don't have enough space for it regularly.
- This was an interesting space that allowed for creative applications that took my teaching one step beyond what I was doing in other classrooms. I would really like to see Solstice used in more classrooms and wall-to-wall whiteboards. This seems relatively easy to implement.
Enhance learning experience

- I believe it allowed a richer interaction between participants and it also enhanced the learning experience.

Q5: What would you add/change/remove from the Bluebox classroom and why?

Larger/clearer/more screen

- I’d also like to have large screens around the room so students can see what’s happening on the main display even if seated away from the front (or back to the front). The main display is large, but the height is limiting factor for aspect ratio so screen share is still quite small for those far away from the front.
- The display was glitchy for two weeks, with the cursor difficult to manipulate and the system crashing once or twice.
- Additional screens to mirror the display of the front screen. Some seats have a bad vantage point.
- Better touch screen up front and easier to navigate
- I really think that the technology (screen, Solistice) needs to be improved upon. Although I used it daily, the screen was my least favorite part of the classroom. I wish the screen wasn’t composed of many different screens because the black edges detract from the images on the screen. Also, I found the small icons difficult to use -- as a touch screen and when using the mouse pad. If there is a way to make them larger, I think that would really help. The Solstice app, also posed a lot of challenges -- in particular, when multiple users tried to log on simultaneously the technology oftentimes froze, kicked people off, etc.
- While the room is espoused as having "no front", the existence of only one display does create a defacto front. I know there are technical challenges, but having displays on each wall would have been nice (though it would cost white board space that was infinitely valuable).
- The touch screen. We tried using the touch features a few times, and it rarely worked in a fluid way. Solstice was great when it worked (most of the time), but it still handles video in strange ways, and sometimes led to us stopping a video 1/2 way through, because it became unwatchable due to either video problems, or the audio and video getting 5+ seconds out of sync.
- My only change would be to make it a bit easier to present a PPT or show a video - the existing system is not bad but it is a bit touchy and it is easy to make your presentation minimize or move around. Not such a big deal for me but for student presentations it stressed them out.

Additional tables and chairs – The additional tables and chairs part-way through the semester was welcome.

Air condition – The air handling system is really loud.

Two-way video – I’d also like to have the room mic’d for two-way video conferencing with remote guest speakers. I have another class in mind that would be perfect in the Bluebox with that addition.
Storage room – The other nice thing would have been if there were some kind of storage for the room. Storage for furniture also would have been nice. There were times when we would have liked to move things in or out of the room to create different configurations, but with a full class, there was really no place to move things too.

A place for instructor – It would be nice to have a better place for the instructor to set up his or her materials (computer, coat, etc.).

Q6: Please describe student comments or reactions--positive or negative--about any aspect(s) of the Bluebox space.

Positive

- The students loved the room! They were quick to adapt to using Solstice and did it from phones, tablets, and computers.
- Students only provided favorable comments except one day when the room was cold and another day when we had trouble with the door locks.
- Students were overwhelmingly positive. They appreciated the ability to write on the walls and leave diagrams for the entire discussion instead of having to erase after each exercise.
- Largely positive.
- Positive experience in the "cafe" (they gave it all different names) decreased anxiety about testing, more engagement and participation.
- Responses were generally positive. The whiteboards and flexible furniture were a plus. Solstice was less popular and had mixed reviews.
- We asked students last week in class to comment on the room, and most all comments were positive (aside from Solstice - students didn’t like that when they had to use it to present things). One student wasn’t sure about the room in week 1, but grew to really enjoy the space, combined with how we ran class sessions, by the end of the semester. Another student liked it so much he tried to come back and use it to study, but found it locked most of the time. One student liked it for classes like ours (active, discussion, activities), but wasn’t sure it would work for things like COMP SCI courses, where everyone often works alone on a personal computer. Just not enough desk space in his opinion.
- They seemed to enjoy the varied seating options and liked the ability to use their personal laptops in the room.

Neutral

- Interestingly, I didn’t get strong reactions either way from the students when I asked.

Negative

- The students were also frustrated by the Solstice app and wireless in the room, in particular, for the reasons stated above.
- One student said it made her feel anxious but I would take that comment with a grain of salt because apparently everything makes her feel anxious.
Direct classroom observations. A goal was to observe each class three times across the semester. When it was time for observations, faculty were notified and asked (a) if a member of the research team could observe and (b) whether there was a preferred class time that week. Across the academic year, the research team conducted 29 observations in 14 different courses. The observation protocol is included in Appendix B.

The protocol allowed observers to note whether faculty and/or students were utilizing the affordances of the space. If so, how were they being leveraged? Researchers defined “affordances” as particular items contained within the space designed to create, or “afford,” opportunities for pedagogical flexibility and creativity. Broadly, affordance categories were furniture, writeable surfaces, and digital displays, or infrastructure. Included among affordances were: the Planar display wall, magnetic white boards, non-magnetic white boards, low tables, high tables, small tables/stools, and soft seating. Additionally, observers noted which devices were used to connect to the display wall (laptops, iPhones, Andriods, iPads, etc.) and who, if anyone, undertook manipulation of the furniture in the space. See Table 3 below for a summary of the usage of these items.

Table 3
Summary of Bluebox affordance utilization

<table>
<thead>
<tr>
<th>Affordance</th>
<th>Instructor or Students or Both (*See note below)</th>
<th>Description/nature of use (e.g., details of group work, ideation, sharing, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planar display wall</td>
<td>I = 21 S = 11</td>
<td>(I) Post small group discussion questions, goals about today’s course and course content (e.g., text, graph, slides online, running r-code)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I) Then the instructor pulled out another program that showed visualization of stars. It was at the center most of the time, but there was a couple of occasions where the instructor would put the program on the right and bring up the PowerPoint slide.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I) Display persistent images</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I) An article citation, a graphic, and 2 sets of questions were on a slide on the display wall when students arrived. The instructor used it to orient student groups to the activity. This seemed to be a fairly traditional kind of activity, but conducted where groups could easily interact.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I) The instructor showed website, and R code as well as result. He also demonstrated how to run the program.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(S) Student display and share their group work (i.e., r-code and graph generated from the r code they wrote)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(S) One student display and share his work (i.e., r-code)</td>
</tr>
<tr>
<td>Magnetic white boards</td>
<td>I = 4 S = 7</td>
<td>(I) Instructor wrote supplementary explanation on the wall... somewhat categorized different information by writing them on different types of whiteboards.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I) Displayed PPT and played four videos (the last one is Mr.King’s “I have a dream”)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I) Display an article and a word documents listing several discussion questions related to the article.</td>
</tr>
</tbody>
</table>
| Non-magnetic white boards | I = 8 | S = 3 | (I) Supplemental information  
(I) Examples  
(S) Group activities, report outs from brainstorming activities |
|---------------------------|-------|-------|-----------------|
| Mobile white boards       | I = 12 | S = 5 | (I) Instructor wrote supplementary explanation as well as a question for students on the boards.  
(I) The instructor draw graph on the board.  
(I) Supplementary explanation of the lecture  
(I) A couple of notes related to a paper they’d read  
(I) Wrote group discussion task on it  
(I) Instructor wrote tasks for student activity  
(I) To Do list for the day  
(I) Drew a picture on it to explain what is Cubic  
(I) Instructor used mobile board to work thru problems that students began independently at the start of class.  
(S) One students wrote group discussion result on it  
(S) Group activities – nature of use is unclear |
| Low tables                | I = 4  | S = 29 | 16 students sat at the low tables and put laptops, textbooks, and notebooks on these tables  
11 students sat on the low tables.  
When I first entered the room, a couple students were seated at the low tables. Before class started, one of them got up and moved to a high table near the front and made sure there were 3 stools around it.  
12 students sat at the low tables and put laptops, textbooks, and notebooks on these tables  
10 students sat on the low tables. |
| High tables               | I = 8  | S = 29 | (I) Instructors tended to put a high table at the front of the room as place for keyboard, laptop, etc. |
Table 3 clearly indicates that, during our observations, students were the primary users of both the low- and high-top tables. Both faculty and students made use of all varieties of white boards. Faculty used the non-magnetic boards more than the magnetic; the alternative was true of students. Sometimes, where the protocol reports only a few students actually wrote on white boards, they were representatives of the larger groups with which they were working (i.e., a “3” under students in the table above may actually represent 12 students). The research team saw evidence of students connecting to the display wall, but faculty were the primary users during observations.

When students connected to the Planar display, they tended to do so from laptops, the majority of which were MacBooks. Instructors tended to connect to the display from their laptops, not iPads, as predicted. (Faculty were offered iPads as an incentive to teach in the Bluebox.)

**Flashbacks.** To better understand ways the Bluebox contributes to the transformation of teaching and learning, the research team created two novel data collection approaches. One is called “Flashbacks.” Flashbacks are reflection prompts delivered weekly to faculty via email. The team employed Boomerang, a Gmail plugin, to schedule prompts in advance. Each instructor received the week’s Flashback prompt 30 minutes following his or her last class session of the week. For example, the instructor team that taught only on Monday evenings received their prompt later Monday evening. The instructor whose final class of the week was Friday at 2:00 pm received his prompt at 2:30. An example of a Flashback prompt is: “Describe how students used technology this week in your class to explore or interact with course content.” (See Appendix C for a full list of Flashback prompts.) The email message contained a link to a Qualtrics survey. Faculty could respond in text or via a video. Although response rates ebbed and flowed, overall, faculty were very responsive. (See Figure 1.) Across the two semesters, the research team curated 260 Flashback responses.
Figure 1. Faculty Flashback response rate by semester week

Weekly Flashbacks provide a rich window into Bluebox experiences. Beyond affirming that flexibility in the space is essential, two major insights emerged from these weekly reflections. First, when provided a space like the Bluebox, faculty develop “activity strings” to engage students. That is, they string activities together to create instructionally diverse learning experiences. Moreover, in time, activity strings and other practices become “instructional routines.” See Table 4 for examples of Activity Strings and Instructional Routines.

Table 4
Faculty voices describing learning activities and instruction

<table>
<thead>
<tr>
<th>Activity Strings</th>
</tr>
</thead>
</table>

“This week I had students discuss a topic in small groups, and the moveable furniture helped to facilitate these conversations. Then I had students report their findings on the marker boards around the room. We then went around the room and each group orally presented their findings, using what they wrote on the walls and marker boards as a “visual aid.” I found that the groups seemed to converse longer about the topics and presented more detailed findings than other times where I have just had students present their findings orally without writing them on the board.”

We used the large screen to display PowerPoints, videos, images, Canvas. It was beneficial to be able to have multiple items up at the same time (for example, posting side by side the results of a survey that was completed at the beginning of class and at the end of class). We used the touch zoom feature frequently! We used solstice once to post student notes for all to see (others used the whiteboards). I showed a video and then I had them circle up when we were discussing similar to a case consultation. I also was able to click through the modules on canvas sitting in a moveable chair up front in the circle as I was discussing the content so it was less of a lecture and more of a discussion.”
This week students used the room to role play family counseling sessions. Two groups used the room in two different ways. One had them drawing pictures on the wall while the other had them doing family sculpting where they used props and chairs and tables in the room to move family members into a variety of poses.

They also used their personal devices to search current news sources for hot topics, and listed these topics on the white boards. This helped us to visually map out possible topics and ways of narrowing/focusing these topics for their upcoming speech assignment.

We were able to collaborate on a complicated advocacy project involving multiple parts and group work, discuss examples of real-life e-portfolios on the smart board and workshop and edit wording on the white boards

Students used chairs and tables to help them create and give their assessment and then they used the different areas of the walls to write out the numbers and calculate the mean, medium, mode, standard deviation, z score, etc. I walked around the room and checked in with them. Each group then led a discussion on what they found. I didn’t lecture at all this week and I think they probably learned the most.

Students worked in groups of 3-4 on an activity while staff circulated. Groups remained the same for the entire class session...after working through guided questions on the tutorial, students had "challenge problems" that they got up to discuss at the white boards to. They had to figure out an approach to solving the problem, following the material we had just reviewed.

We got up on the white boards and drew essentially empty graphs and had students reading about interest curves...on the y axis is interest level and on the x axis is time. So what we did is we drew a bunch of interest vs. time, y and x axes on the wall at different points around the edge of the room, and after we talked about interest curves for a while,...we would pick on a specific student and ask that student to get up and draw an interest curve related to a specific game that the student had played recently. After they drew the interest curve and the graph we would then ask them to explain it to us and walk us through it.

I tried a new activity where students worked in groups to locate examples of course concepts in magazine ads. When they found one, I asked them to take a picture of it and use solstice to display the ad on the screen to make it easier for their classmates to see the ad while each group described their analysis.

Instructional Routines

Pretty consistently with the way I have used it all along, I presented material electronically on the large board and I drew and the portable boards to facilitate discussion of the material.

We didn’t do anything this week that we hadn’t tried in the previous three weeks, but in those weeks we were able to use a different chair/table layout every week, use solstice, movable white boards and wall white boards for displaying group notes and really effectively show video content because of the size of the screen. We also have shown multiple windows on the large screen almost every week.
The general idea is to introduce a topic through lecture or discussion, then allow students to break into teams and demonstrate application of the day’s concepts through a worked example, which is then shared back with the class.

I used the display wall to display a ppt file and a pdf with figures and questions to guide class discussion. We also used the whiteboard to work out some equations that went with a figure that was being projected. I love being able to write on the walls.

I continue to use the ipad to display questions and to work out derivations/notes for students. We use the whiteboards for the students to work out problems in groups and present the results. We also use iclickers.

As the semester moves along, integration of the various Bluebox affordances is becoming more second nature to us as instructors and as a byproduct, class has become a much more active, participatory experience. A lot less time in class is devoted towards traditional lecture. Though we did not set about to “flip” the classroom, the room lends itself to more active approaches to teaching and it is equal parts energizing and effective to take advantage of it. Just about every class has opportunities for students to leverage Solstice or whiteboards in some capacity, which itself sparks discussion and makes class a much richer experience

We have been consistently using the large screen to display materials and discussion questions. Occasionally students will also upload materials that they want to share onto the screen, which is useful.

As we do with every class, students worked in small groups in the second half of the class when they applied ethical frameworks to the topic of the week. These are the same groups each week. They are all together as a whole class for lecture and discussion for the first half of class...The flexibility of the tables and chairs allows us to create different environments, even within one class period, which I think reinforce the kind of thinking and learning we want from them in those instances.

Re-Capture. “Re-Capture” is a second novel data collection approach, one in which Bluebox faculty were invited to consider “re-captured” configurations of the classroom space. Re-Capture has two components: Re-Capture - Configure, a data collection component and Re-Capture - Consider a faculty development component. Data were visual representations of classroom configurations created by the faculty; faculty development came in the form of sharing configurations with a multi-disciplinary group of teaching colleagues.

Re-Capture – Configure. During the fall semester 2016, the small cohort of Bluebox faculty attended a meeting in the classroom space where they engaged with both a Re-Capture board and a reflective prompt that asked them to: Re-capture a configuration of the space that allows you to do something different (instructionally, pedagogically) in your course that either you could not do before or that was difficult [in a traditional classroom space]. A white foam core board was placed on a high-top table in the Bluebox. Instructors and a researcher stood around the table with the Re-Capture board on the table in the middle. The faculty members took turns creating configurations of the space in response to the prompt. They moved and situated laminated representations of the furniture and, in some cases, annotated using a dry erase marker. See Figure 2 for an example of one instructor’s response and the researcher’s notes from the conversation.
As each faculty member manipulated furniture and mobile whiteboards on the Re-Capture board and shared his or her response to the prompt, others were able to react and ask questions. This environment provided all participants not only an opportunity to share their responses but to learn from the ideas of others.

By Spring 2017, the high number of faculty (n=16) required the research team to create a new way to collect faculty-generated configurations. The solution was to leverage Google’s Drawing application. A TLT multimedia designer rendered the perimeter of 101 Althouse Lab in a Google Drawings space and also created representative “pieces” of all the furniture and mobile whiteboards. (See Figure 3.) At the time of data collection, a unique link was sent to each faculty member. Each was asked to respond to the same prompt that was used in the fall, but this time they were instructed to drag and drop the furniture pieces to Re-Capture their response. Within the same Google Drawings interface, they provided details about why that configuration worked for them. Faculty were then convened to share and discuss their Re-Captures. As in the fall, this discussion served as a faculty development opportunity in which instructors could share their responses and also learn from the ideas of others.
Participation in these exercises and discussions was high. Seventeen out of 20 faculty engaged in the Re-Capture - Configure exercise. The faculty-generated configurations revealed wide variability in layouts of the classroom. As expected, the space was arranged to suit the practical/logistical and pedagogical needs of the course. See Appendix D for the configurations from Fall 2016 and [this link](#) to view the 12 configurations generated in Google Drawings during the spring semester.

Across the faculty, there were reports of creative and engaging configurations. Two examples give insight into the kinds of specific, and meaningful, changes faculty reported being able to make as a result of teaching in the Bluebox. See Table 5.

Table 5
**Example configurations and accompanying responses to the provided prompt**

<table>
<thead>
<tr>
<th>Instructor A taught a 400-level course in Nutritional Sciences. The focus of the course is nutrition counseling. There were 27 students enrolled.</th>
<th>Faculty-generated room configuration</th>
<th>Instructor’s pedagogical aims that the configuration helps to facilitate</th>
</tr>
</thead>
<tbody>
<tr>
<td>“The most significant change I was able to make was to divide the groups into two or three students and place them around the room and on both sides of the white boards and they were able to brainstorm and work in small groups standing up while I was able to physically SEE what they wrote and easily move around the room and interact with them. I was able to “catch” them doing their work well and also correct misconceptions easily. In the traditional classroom, all of their work was done sitting down and on paper and I never had the ability to interact with each small group in the same manner.”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Instructor B taught a section of CAS 100, a course on public speaking. There were 26 students enrolled in the course.

“Because public speaking is a nerve-racking activity, in typical classrooms students tend to hide behind the podium as much as possible. In the Bluebox Studio this isn’t possible! So, I have noticed that students seem to use the space in the front of the classroom much better in this space than in traditional classrooms. Students move around more to emphasize key points of their speech, for instance and they are more attuned to body language.”

Re-Capture – Consider. During both fall and spring semesters, faculty were invited to the Bluebox space for a second Re-Capture meeting. As with the first Re-Capture meeting, there was an intentional plan both to collect data for research purposes and to leverage the exercise for faculty development. Thus, there were two questions driving the content of the second Re-Capture meeting:

1. What configurations are most compatible with the pedagogical goals of the faculty? (research question)
2. How can we leverage this our data collection process to provide an opportunity for faculty engagement and cross-disciplinary conversation? (faculty development question)

To address the first question, the researchers prepared a set of PPT slides with pre-determined configurations for the faculty to consider. These were not, however, presented as slides. Instead, at the meeting each instructor was handed a hard copy set of printed PPT slides in “notes” format. That is, there were five sheets, each with one configuration at the top of the page with space for notes at the bottom. The set of configurations provided in the fall with the physical foam core board with pieces is shown in Figure 4A. These were created by the researchers. Figure 4B depicts the set of images provided to faculty during the spring meeting when configurations were created in the Google Drawings application. These were selected by the researchers for this exercise from among those generated by members of the faculty cohort.
Figure 4A depicts the white foam core Re-Capture board with moveable laminated furniture pieces. Figure 4B shows the Re-Capture board, built in the Google Drawings application, with drag-and-drop furniture and white boards. The prompt was the same during both semesters.

Note. To aid communication of findings, it is helpful to refer to each configuration by a name that conjures a mental image of the space and of the kinds of activities that might occur there. For example, the configurations may be labeled as: (1) debate, panel; (2) small or large groups or clusters; (3) presentation, demonstration; (4) group circle or fishbowl (if a second concentric circle is added); and (5) poster session, “cocktail party.”

Following a brief framing discussion about “built pedagogy” (Monahan, 2000), faculty were asked to consider each configuration and rank its compatibility with their instructional and pedagogical goals (see Figure 5). How each was ranked by 11 faculty participants is provided in Table 6.
**STEP 1**

Rank the 5 configurations in order from *Most compatible alternative/option* (#1) to *Least compatible alternative/option* (#5). Number each page in rank order.

*Most compatible alternative/option* = Well-matched to at least one of your instructional goals; you believe this configuration could add value to your students’ learning experience; you might consider actually setting the room up this way some time.

*Least compatible alternative/option* = Poorly-matched to any of your instructional goals; you can’t imagine this configuration adding value to your students’ learning experience, and it may actually inhibit learning; you would not consider ever actually setting the room up this way.

**STEP 2**

For each configuration you can imagine leveraging in your course, briefly explain the context where it could prove useful. How would the space configuration add value?

For each configuration you cannot imagine leveraging in your course, what factor(s) would prevent you from doing so (consider curricular, pedagogical, logistic, practical, etc.)?

*Figure 5.* Instructions for ranking Re-Captured configurations.

<table>
<thead>
<tr>
<th>Table 6</th>
<th>Instructor ranks of configuration compatibility with instructional and pedagogical goals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rank by type</td>
</tr>
<tr>
<td>Instructor</td>
<td>Debate</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
</tr>
</tbody>
</table>

There are at least three important observations to highlight in Table 6 above. The Bluebox classroom was designed as a technology-enhanced active learning classroom. As such, there is an expectation for student interaction and collaboration. Although, each of the configurations imply some measure of interaction, the “small groups” category is perhaps the most ALC-like. That is, we expect students learning in a space like the Bluebox to be doing so in collaboration and cooperation with peers in groups. Of the 11 instructor profiles, nine rank small groups as either 1 or 2. The two that ranked small groups a 3 out of 5
are a public speaking instructor and an IST instructor whose 400-level course is largely led by student presenters. Instructors 1-5 comprised the fall faculty cohort. Each presented a profile of ranks that was different from the others. When the spring faculty are added to the matrix, there begins to be some overlap in rank profiles, but new insights emerge. For example, Instructors 2 and 3 have identical rank profiles, but the courses are very different. One was a 400-level IST game design course with 43 enrolled students, while the other was a 12-student seminar in Biochemistry and Molecular Biology.

During the Re-Capture exercises, the faculty themselves began to assign names to effective configurations. For example, one utilized what he branded a “Campfire” configuration; while another reported on the benefits of starting class sessions with an “Island” configuration. Such faculty-generated conceptualizations can be leveraged with future cohorts of Bluebox instructors.

A number of specific insights emerged specifically from the Re-Capture approach:
- There are categories of configurations that work for different pedagogical purposes; for example, small groups, debates and panel discussions, student/guest presentations, informal mingling and presenting.
- No single configuration is optimal for every instructor in every teaching context. The Bluebox is leveraged in different ways in different disciplines, by different instructors, and depending on instructional purpose.
- The cohort approach is a de facto Faculty Learning Community, if only for a semester. Although we did not design research questions specifically around faculty engagement, the team noticed clear benefits to convening faculty for conversations around teaching and learning in the Bluebox.

These findings support that flexibility is essential for freeing faculty to create the best space configuration for the instructional and pedagogical goals they seek to achieve. Moreover, instructors can only imagine what they can imagine. When there are opportunities to hear about what other faculty are doing in the space, these possibilities expand.

**Faculty Participation in TLT Research Activities**

Unlike at other institutions that are doing learning spaces research and faculty development, TLT undertook to do so with no monetary incentives. Faculty participation in Re-Capture activities was reasonably high. (See Table 7.)

<table>
<thead>
<tr>
<th>Semester</th>
<th># of Configurations</th>
<th># of Faculty participants in Re-Capture discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2016</td>
<td>5 (100% of courses)</td>
<td>6 (100%) (2 were a team and shared as a team)</td>
</tr>
<tr>
<td>Spring 2017</td>
<td>12 (75% of courses)</td>
<td>11 (69%) (2 were a team and shared independently)</td>
</tr>
</tbody>
</table>
Student Data Sources

Data were collected from enrolled Bluebox students by two methods: An end-of-course survey and focus groups.

End-of-course survey. Two weeks before the end of the semester, an end-of-course-survey was accessible to students via their course Canvas site. In total across two semesters, 58 students completed the survey: 9 students from Fall 2016, and 49 students from Spring 2017. The only difference between the two versions of the survey is that the old version contained one item with a technical problem with the Qualtrics interface. Among the 49 students who completed the survey in spring 2017, 10 completed the old version. What follows is based on the responses of the 58 students on all survey questions, except the one faulty item. There were missing values with a missing pattern of completely random. The percentage of missing was 2%. The full survey can be found in Appendix E.

Eighty-five percent of the students were undergraduates. Thirty-four students (59%) indicated that the course they took in the Bluebox classroom was required; 24 students (31%) indicated their course was elective. Laptop was selected as the most useful personal device to support academic. Forty students (69%) would like to take additional courses in a classroom designed like the Bluebox, five students (8.6%) preferred not, and 13 students (22.4 %) selected “Neutral/Not sure”.

Seven items were used to gauge instructor’s TPACK from students’ perspective using a 5-point scale anchored by 1 (Not at all true) to 5 (Very true). The total scores for individual instructors ranged from 14 to 35, with a mean of 28.79, and a standard deviation of 5.89. The frequency statistics for each item provided in Table 8. Overall, students perceive their instructors to be relatively savvy at integrating technology with pedagogy in their classes. Each of the first five items below was endorsed by more than 72% of student respondents as either a 4 or a 5. The last two items were highly rated by fewer students. Thirty percent of student respondents rated Item 6, “My course instructor is able to integrate content, technology, and teaching methods in his/her teaching,” a 3 or lower. Item 7, “My course instructor is able to choose diverse technologies and teaching methods for a specific course unit,” was rated a 3 or lower by 41% of respondents. This is informative, as these may be areas to focus faculty development.

Table 8
Distribution and frequency statistics of 7 TPACK items

<table>
<thead>
<tr>
<th>Question</th>
<th>Distribution and Frequency for Each Option</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>My course instructor knows how to use multimedia (e.g., PowerPoint and animation, etc.) for teaching.</td>
<td></td>
<td>0.00%</td>
<td>0%</td>
<td>7.69%</td>
<td>15.38%</td>
<td>6</td>
<td>33.33%</td>
</tr>
<tr>
<td>My course instructor knows how to use web technologies (e.g., teaching website, blog,</td>
<td></td>
<td>2.56%</td>
<td>1%</td>
<td>2.56%</td>
<td>1</td>
<td>23.08%</td>
<td>9</td>
</tr>
</tbody>
</table>
distance learning) for teaching.

| My course instructor is able to choose multimedia and web technologies that enhance his/her teaching for a specific course unit. | 0.00% | 0 | 5.13% | 2 | 20.51% | 8 | 23.08% | 9 | 51.28% | 20 | 39 |
| My course instructor is able to use technology to enhance our understanding and learning of lessons. | 0.00% | 0 | 7.69% | 3 | 17.95% | 7 | 33.33% | 13 | 41.03% | 16 | 39 |
| My course instructor is able to use technology to enrich the teaching content and materials. | 0.00% | 0 | 7.69% | 3 | 15.38% | 6 | 35.90% | 14 | 41.03% | 16 | 39 |
| My course instructor is able to integrate content, technology, and teaching methods in his/her teaching. | 0.00% | 0 | 5.13% | 2 | 25.64% | 10 | 28.21% | 11 | 41.03% | 16 | 39 |
| My course instructor is able to choose diverse technologies and teaching methods for a specific course unit. | 2.56% | 1 | 5.13% | 2 | 33.33% | 13 | 23.08% | 9 | 35.90% | 14 | 39 |

To further understand how the classroom design for the Bluebox influenced students’ learning experience, five open-ended questions were included in the survey. Student responses are listed under each question below.

Q1- How did the classroom design for the Bluebox in 101 Althouse contribute to OR detract from your willingness to ask questions in class or participate in class discussions?

**Contributed to**

- I felt fine asking questions in the classroom.
- Contributed because I could see the questions in large print and up close.
- I enjoyed collaborating with my classmates through writing our ideas on the various walls of the classroom.
- Made discussions feel more interactive
- Allows for the display of the figures we are discussing and is really helpful for presentations
- The room setup allowed for open discussions and it felt more natural to participate than a typical classroom
- It allowed us to put articles up on the board for all of us to see
- It made us want to ask more questions. It was easier for people to participate
The many white boards and the technology helped a lot
It created a open environment which makes people more willing to speak out.
It contributed since I was able to share my notes to the screen and practice presentations much easier to get quality feedback from everyone else in my class.
It felt very open and comfortable.
The personal and relaxed setting made classroom conversation much easier.
It made everything very interactive and easy to share.
The writing walls were great for small group work and brainstorming
Made it easier to meet in groups
It contributed because of the nice distance from everyone. People were able to make friends more also so everyone felt more comfortable to talk in class.
The whiteboard walls really help because you can participate in groups or as a whole class and when describing something there's always something to write on.
The boards were nice to allow students to work on their own and show others their work.
The environment felt warmer and more inclusive, so I was more confident.
It encouraged group work, so we asked a lot of question to those sitting around us.
The layout of the room made it harder for me to ask questions as I was off to the side
Great

Detracted from

The interface is not well designed for teaching because even something such as pointing to the screen causes it to change. This is a bit distracting. For the most part I can understand why we used the multimedia room, but honestly the course would probably be better suited for a room with two projector screens. No one ever projected anything of their own on the smart screen so it was not necessary.
The 8-panel display was so cumbersome to use that I didn’t want to ask any questions that required presenters to move away from the exact view that we were looking at during that very moment.
The black lines between different monitors in the giant screen creates distraction and blocks the visibility of displayed content. Also, the aspect ratio of the screen is not good for viewing content at a distance. We could not utilize the whole of the screen.
It distracted me because often the PowerPoint presentations would go away from the misuse of the big touch screen.

Neutral

It didn’t change how often I asked questions.
It did not really affect my willingness to participate
It didn't contribute nor detract me from participating class
No change, asked when needed
It didn’t

Q2 - How did the classroom design for the Bluebox in 101 Althouse contribute to OR detract from your ability to stay focused during class?
Contributed to

- The classroom design is nice because it has a lot of seat options and a lot of space to write on whiteboards.
- The design allowed me to stay focused easily and swivel to face wherever the professor was.
- It helped me stay more focused.
- It was a large projector so that was the main focus of the room.
- Made it easier to focus
- Contributed by allowing us to watch videos in class more easily
- Allows for better visuals to focus on during class
- There was a lot of seating space that was nice
- It contributed to the focus of class. Bigger board and graphics helped.
- The white walls were very helpful
- Spinny chairs are dope.
- The classroom design helped me to be more interactive with the lesson so I was more engaged.
- It definitely did not impair my focus, but made the class more exciting
- Kept me more focused
- I liked looking at all the walls
- It still contributed because of the set up. Everything was pointed toward the speaker.
- I think it helped me stay focused because the course material was all around me and kept my attention
- I usually sat at a high table, which allowed me to see everything more clearly. The less typical classroom also kept things interesting so I paid closer attention.
- Good

Detracted from

- Computer screen too big and daunting. Does not seem user friendly.
- The classroom would get quite cold very quickly.
- I found it hard to stay focused when my professor experienced trouble with the technology, which took away class time
- The 8-panel display was a clumsy mess.
- Detracted because the "multiple TVs" lines interfered with being able to read text. Also things on full screen were too stretched out and hard to read
- Maybe if we were sitting in small groups around the class, it was more difficult to stay focused, but this was not a huge problem.
- The lines on the screens is very distracting. Sometimes it cuts off what I am trying to read
- It detracted because the class is so much bigger, it’s harder to pay attention sometimes.
- Couldn’t really focus felt so big.
- I don’t like whiteboards
- Constant interruptions of reminders from Solstice distracted attention.
- Class was often disrupted because of not understanding how to use the technology properly.
detracted from my focus it was hard to see

Neutral

- Never had a lecture, cannot compare
- I didn't feel any difference in my ability to focus.

Q3 - How did the classroom design for the Bluebox in 101 Althouse contribute to OR detract from your interactions with other students?

Contributed to

- We could easily position ourselves to share ideas with one another.
- Aided my ability to display and explain various things to other students
- The classroom design worked very well for group work.
- Contributed more
- It increased my interactions since we would gather in small groups and come up with ideas before presenting them in a group to the rest of the class.
- We all sat together.
- Communications was clear.
- It was really nice to be able to move the tables and chairs around for collaboration.
- It made me more able to interact with students.
- The whiteboard walls were the most useful feature. The flexible furniture options were also helpful.
- The table arrangement was very helpful.
- It contributed to more interactions because small groups were able to be formed with the various tables and chairs throughout the room, and the whiteboards were helpful to write ideas and communicate with each other
- I guess the openness of the forum that was created helped it.
- Definitely made interactions with students in class much easier.
- Contributed greatly to a collaborative learning space.
- It really contributed to interactions with other students because there were so many separate spaces. I made friends by sitting with people at one table and talking to them every day.
- I believe the room encouraged interactions with other students due to the modular seating.
- Definitely helped us work in groups and interact
- The tables were a huge factor in creating conversation. The relaxed feeling of the room also encouraged more conversation.
- The ability to move around and sit comfortably made interacting with other people a whole lot easier.
Detracted from

- I'm not sure if the dynamics of the students created a sense of awkwardness, or the physical environment gave a slight sense of cliques.

Neutral

- Didn't help or hurt.
- About the same
- It didn’t contribute nor detract my interactions with other students
- Did not contribute or detract.
- no change from any interactive class
- It didnt
- The class was not much about interactions so I cannot give an opinion

Q4: What features of the classroom, if any, made it an effective learning environment for you?

- Whiteboard walls
- The amount of seats available
- White board walls
- Whiteboard walls
- Big screen
- The screen
- The whiteboards and the large screen
- White boards, big front display, small tables and chairs dispersed around the room
- The ability to project things easier on the board was useful
- The ability for anyone to put their screen on the board.
- The table arrangement and the white boards
- Whiteboard everywhere
- How everything was a writing surface
- The tables were nice, like big desks
- Openness, everything is very spread out.
- Open nature of the classroom, and the white boards that could be written on.
- the walls
- I really liked the comfort provided in the chairs.
- White board walls were great. Loved all the chairs and tables so you can work with other people in a lot of different ways. The giant board was nice.
- Movable seating
- Seating and openness
- The set-up of the tables and chairs, along with the outlet stands around the room.
- the “desks” set up as tables and just the general setup - it didn’t feel like a middle school or high school classroom. it was better.
- The high tables and the large screen. The whiteboards and walls were also awesome resources.
- white board walls
- White board are great. I love them so much!
Q5: If you could spend your time in any one part of the Bluebox space, which would you prefer? Why?

![Bar chart showing frequencies of student furniture preferences.](chart)

**Figure 6.** Frequencies of student furniture preferences.

### Soft seating

- The soft seating was very comfortable.
- More comfortable.
- I sat in a soft chair the entire duration and it made me feel more at ease in the classroom.
- Comfier
- Seats were pretty dope.
- Very comfortable, but I like having a table.

### Traditional tables and chairs

- Most people don’t think about this when designing a space but for short people like me finding seating that allows my feet to touch the ground is almost impossible. These chairs had bars I could prop them on so they were comfortable and ergonomic to sit in.
- Good for group discussion
- I like having the options of the soft chairs and the high-tops, but if I need to choose only one then it would be comfortable standard-height tables and chairs.
- I felt more engaged at the longer table and the chairs were still comfortable.
- I like having my own space on a table as opposed to a folding desk
- More versatility
- The table arrangement is very interactive and makes the group work easier
- Need a desk to write on, too short for the high top chairs
- I am used to traditional tables and chairs in classroom environments that could be moved into different configuration -- I also like the soft seating sometimes.
- The chairs were much more comfortable than in a standard lecture hall.
High-top café tables and high chairs

- Just because of the fact that it is different and unique made it more exciting to sit there.
- I always sat at the high tables. Easier to view everything.
- It gives me a high advantage to see everyone and I feel that I can see the board better.
- As a shorter person, I find that it helps me to see everything in the room. While soft seating would be nice, I think I would be too comfortable and it might take away from my focus.
- it’s different from a normal class room but still has chairs and tables to do work
- I was able to see more of everything. It’s also simply more comfortable for me.
- Feel so comfortable

Focus groups. Students were invited to participate in focus group both in the fall and in the spring. (See Appendix F for focus group questions.) In spite of faculty encouragement to attend and the promise of pizza and drinks, turnout was poor in the fall and non-existent in the spring. For the few who provided feedback in Fall 2016, their few insights were not novel beyond what was learned from other data sources. The research team will incentivize differently in the future.

Conclusions and Implications

Multiple sources of data provide important insights into the experiences of faculty and students in the Bluebox. Importantly, lessons learned can be transferred to future classroom design projects and to planning for faculty development.

One conclusion is that for the first two Bluebox faculty cohorts, the Bluebox likely did less to change their teaching and more to support the kinds of instruction they had been doing with difficulty in traditional spaces. As one instructor noted, “This semester, the way I have taught the class did not change, but it worked as I had always envisioned it should, in contrast to frequent problems in standard rooms.”

Data collected from faculty and students broadly suggest that:
- Instructors need flexible spaces that can be reconfigured to match pedagogical approaches and instructional goals.
- In spaces with the collective affordances of the Bluebox, instructors have more opportunities to create “activity strings,” where multiple kinds of learning activities are stitched together, and to experiment with new “instructional routines” to facilitate learning.
- Writeable walls and moveable whiteboards should be classroom standards to help make student thinking and learning visible and vertical, where ideas can be more easily shared and feedback more readily provided.

Said one instructor in a Flashback reflection, “I believe the [Bluebox] lab space has fostered an incredible sense of community, and, as a result, the class has been able to have intimate class discussions. The class has truly become a safe space for the exchange of ideas and has fostered new intellectual and personal connections I don’t think would have happened in traditional classroom spaces.”
References


Appendix A
Faculty Pre- and Post-Survey

Faculty Pre-Course Survey

**Questions about development of this measure relative to TPACK should be addressed to Crystal Ramsay.**

Demographic items

From:

1. What is the name of the course that you are teaching in 101 Althouse this semester (e.g., HIST 101, Introduction to Western Civilization)?
2. How many students do you expect to be enrolled in the course?
3. Will they be primarily undergraduate or graduate students?
4. How many times have you taught the course previously?
5. Think about the instructional techniques that you typically use during class time for this course. Estimate the percentage of time that you generally devote to each over the semester. If you have not taught the course previously, you can base your estimates on your plans for this semester.

<table>
<thead>
<tr>
<th>Teaching technique</th>
<th>% of class time over the semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture/presentation</td>
<td></td>
</tr>
<tr>
<td>Class discussion</td>
<td></td>
</tr>
<tr>
<td>Small group activities</td>
<td></td>
</tr>
<tr>
<td>Student presentations</td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>100%</td>
</tr>
</tbody>
</table>

6. When you have taught this course in the past, can you think of any time when the layout of the room and furniture made it difficult to use (or discouraged you from using) a particular teaching technique? (Circle or highlight one.)

   Yes                   No

   Please explain.

7. When you have taught this course in the past, how often did you take class time to move furniture around to accommodate different learning activities? (Circle or highlight one.)

   Never              Occasionally        Regularly

8. If you answered occasionally or regularly for Question #8, please describe the learning activities that required rearrangement of the furniture.

Strongly Disagree= SD Disagree= D Neither Agree/Disagree= N Agree= A Strongly Agree= SA

a) Pedagogical Knowledge (PK)
1. I know how to assess student performance in a classroom.
2. I can adapt my teaching based upon what students currently understand or do not understand.
3. I can adapt my teaching style to different learners.
4. I can assess student learning in multiple ways.
5. I can use a wide range of teaching approaches in a classroom setting.
6. I am familiar with common student understandings and misconceptions.
7. I know how to organize and maintain classroom management.

b) Technological Content Knowledge (TCK)
I know about technologies that I can use for understanding and doing my discipline (e.g., Chemistry, GIS, History).

c) Technological Pedagogical Knowledge (TPK)
1. I can choose technologies that enhance the teaching approaches for a lesson.
2. I can choose technologies that enhance students' learning for a lesson.
3. I am thinking critically about how to use technology in my classroom.
4. I can adapt the use of the Bluebox technologies to different teaching activities.

d) Technological Pedagogical Content Knowledge (TPACK)
1. I can teach lessons that appropriately combine my discipline, technologies, and teaching approaches.
5. I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.
7. I can provide leadership in helping others in my department to coordinate the use of content, technologies, and teaching approaches.
8. I can choose technologies that enhance the content for a lesson.
Post-Course Survey

Demographic items:

9. What is the name of the course that you taught in 101 Althouse this semester (e.g., HIST 101, Introduction to Western Civilization)?
10. How many students were enrolled in the course?
11. Were they primarily undergraduate or graduate students?

12. Think about the instructional techniques that you used in the Bluebox classroom. Estimate the percentage of time that you devoted to each over the semester.

<table>
<thead>
<tr>
<th>Teaching technique</th>
<th>% of class time over the semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture/presentation</td>
<td></td>
</tr>
<tr>
<td>Class discussion</td>
<td></td>
</tr>
<tr>
<td>Small group activities</td>
<td></td>
</tr>
<tr>
<td>Student presentations</td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
</tr>
</tbody>
</table>

100%
Please specify how often you and your students used each of the following in 101 Althouse this semester:

<table>
<thead>
<tr>
<th>Small photo ↓</th>
<th></th>
<th>Every or almost every class</th>
<th>Occasionally</th>
<th>Rarely</th>
<th>Did not use</th>
<th>Comments about how classroom amenities/affordances were used, if beyond typical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Instructor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planar wall display</td>
<td>Instructor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile whiteboards</td>
<td>Instructor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnetic white board by the main door</td>
<td>Instructor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whiteboard located at the back of the room (opposite the Planar wall)</td>
<td>Instructor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnetic whiteboard located to the right of the Planar wall and the left of the window</td>
<td>Instructor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Strongly Disagree= SD Disagree= D Neither Agree/Disagree= N Agree= A Strongly Agree= SA

a) Pedagogical Knowledge (PK)

1. I know how to assess student performance in a classroom.
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5. I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.
7. I can provide leadership in helping others in my department to coordinate the use of content, technologies, and teaching approaches.
8. I can choose technologies that enhance the content for a lesson.

1. What would you add/change/remove from the Bluebox Classroom and why?
2. Would you recommend teaching in the Bluebox Classroom to a colleague?
Appendix B
Bluebox Classroom Observation Protocol

The purpose of this protocol is to capture details at the intersection of space, technology, and pedagogy. In particular, observers should seek to capture instructor-driven activity and behavior, room use, and overall instructional culture to facilitate student learning.

Course:
Instructor:
Time of day:
Number of students:

For each of the classroom characteristics/affordances below, please indicate:
- Whether it is being used/leveraged by the instructor (I) and/or the students (S) or both
- A description of HOW it is being used/leveraged

<table>
<thead>
<tr>
<th>Affordance</th>
<th>Instructor or Students or Both (circle)</th>
<th>Description/nature of use (e.g., details of group work, ideation, sharing, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planar display wall</td>
<td>I S</td>
<td></td>
</tr>
<tr>
<td>Magnetic white boards</td>
<td>I S</td>
<td></td>
</tr>
<tr>
<td>Non-magnetic white boards</td>
<td>I S</td>
<td></td>
</tr>
<tr>
<td>Mobile white boards</td>
<td>I S</td>
<td></td>
</tr>
<tr>
<td>Low tables</td>
<td>I S</td>
<td></td>
</tr>
<tr>
<td>High tables</td>
<td>I S</td>
<td></td>
</tr>
<tr>
<td>Small tables/stools</td>
<td>I S</td>
<td></td>
</tr>
<tr>
<td>Soft seating</td>
<td>I S</td>
<td></td>
</tr>
</tbody>
</table>
If the display wall was utilized, which devices were used to connect to it (laptops, iPhones, Androids, iPads, etc.)? Note numbers of each, if possible.

If furniture configurations were manipulated, was this activity directed by the instructor or voluntarily undertaken by the students to facilitate interaction and task completion? Describe.

**USE THE PERIMETER LAYOUT OF THE ROOM TO ALLOW FOR MAKE ADDITIONAL NOTES.

Note: During Fall 2016, the room’s architectural drawing was used as the perimeter; during Spring 2017, observers used the same Google Draw perimeter that faculty used in the Re-Captures.
Appendix C
Flashback Prompts and Schedule

What they looked like (some repeated, some didn’t; TPACK framed

<table>
<thead>
<tr>
<th>Prompt</th>
<th>Week(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe how students used technology this week in your class to</td>
<td>3, 7, 11, 15</td>
</tr>
<tr>
<td>explore or interact with course content.</td>
<td></td>
</tr>
<tr>
<td>In what ways did you take advantage of the technology in the</td>
<td>4, 8, 12</td>
</tr>
<tr>
<td>Bluebox/Learn Lab this week? This can include the whiteboards,</td>
<td></td>
</tr>
<tr>
<td>student-owned technology, the display wall, or technology you brought</td>
<td></td>
</tr>
<tr>
<td>to the classroom.</td>
<td></td>
</tr>
<tr>
<td>Do you plan to revise and/or add a learning activity based on your</td>
<td>5, 9</td>
</tr>
<tr>
<td>most recent experience in this space? If so, what? Why?</td>
<td></td>
</tr>
<tr>
<td>Describe how technology in the Bluebox classroom/Learn Lab enhanced</td>
<td>6, 10, 14</td>
</tr>
<tr>
<td>your teaching and student learning over the last 3 weeks.</td>
<td></td>
</tr>
<tr>
<td>What collaborative activities were done in the space? Did the group</td>
<td>13</td>
</tr>
<tr>
<td>membership remain the same throughout the class session, or were</td>
<td></td>
</tr>
<tr>
<td>they reconstituted?</td>
<td></td>
</tr>
<tr>
<td>Were you able to try something new in class this week, from a pedagogy</td>
<td>7, 11</td>
</tr>
<tr>
<td>or technology perspective, because of some aspect (physical or</td>
<td></td>
</tr>
<tr>
<td>technological) of the Bluebox classroom</td>
<td></td>
</tr>
<tr>
<td>Did the affordances of the Bluebox classroom allow you to exercise</td>
<td>13</td>
</tr>
<tr>
<td>students’ higher level, or critical thinking, skills this week? If</td>
<td></td>
</tr>
<tr>
<td>yes, please describe.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix D
Faculty-generated Re-Capture Configurations

These images reflect the graphic responses to the prompt: Re-capture a configuration of the space that allows you to do something different (instructionally, pedagogically) in your course that either you could not do before or that was difficult [in a traditional classroom space].

Fall 2016

Instructor 1 - This instructor teaches Astronomy. There are 21 students enrolled. The class is characterized by lots of discussion. Once or per class the instructor presents a question to the students via the Mersive/Solstice display. Students work in groups to discuss and graphically explain answers on the mobile white boards. These are then clustered near the display wall. As the instructor discusses the answers to the questions, there is discussion about how close the students came to answering correctly. Instructor 1 says that, while Q & A has always been foundational in this course, it looked like traditional Q & A. Now, in contrast, students can collaborate, record their ideas, and compare their thinking to the instructor’s. The instructor leaves the room configuration as it was left by the previous class. Other than extensive use of the white boards, there are no other furniture changes.

Instructor 2 - This instructor teaches Statistics. It is not only the first time the course is in the Bluebox, it’s also the first time the class is being taught at all. There are 32 students in the class. Students are assigned to groups for assignments and projects. The course is modeled on a flipped classroom design, where students get their first exposure to new content outside of class. They take an online quiz then come to class, ask questions, and work on assignments. White boards are available to each group. Class begins with students addressing “muddiest points” in groups. They later work on the weekly group project.
**Instructor 3** - Instructor 3 is really two instructors. The course is Biochemistry and Molecular Biology and it’s team taught. There are 13 upper level undergraduates enrolled. Each class begins with a configuration the instructors call the "Island;" all students sit around the center furniture. When it’s time to break out into groups, one group stays at the center while the other move. In the previously assigned space, the instructors had to choose between large group and small group exercises. With the flexible furniture in Althouse, they do note have to choose. They can do both. Additionally, in the previous space, whiteboard space was very limited, often inaccessible behind the screen in the room. Now there is ample whiteboard space.

**Instructor 4** - Instructor 4 teaches a class of 16 undergraduates in Information Sciences and Technology. Student leaders present globalization topics to their classmates. The leaders operate the Solstice display. The instructor reports that in rooms where the course is typically assigned, there are bad sight lines. In other words, there are places in the rooms where seeing other parts of the classroom are difficult. This is not the case in the Bluebox. Tiered furniture prevents such partial views. Notable in the configuration is that the student leaders are given the “comfy” chairs.
Instructor 5 - Like Instructor 4, Instructor 5 has built the class around student presentations and class facilitation. This is, however, a graduate class of 16 students. The course is designed such that the instructor actually teaches for the first two weeks. After that, teams of student presenters/facilitators work with their classmates. They do activities such as skits and case studies. Students can choose to present their content in any way, using any mechanism, they choose.
Appendix E

Student End-of-Course Survey
(Questions were administered via Qualtrics.)

Demographic items
What is your semester standing?
__ First year students
__ Sophomore
__ Junior
__ Senior
__ Graduate student

What course are you currently taking in the Bluebox Classroom? _______________________

Is the course you’re taking in the Bluebox classroom (Choose one)
__ A course in my major
__ An elective

Which of the following personal devices do you use to support your academic work at Penn State? (Choose all that apply)
__ Smart phone
__ iPad
__ Laptop
__ Tablet
__ Other

Which of your personal devices did you find to be most useful in the Bluebox classroom? (Please select only one)
__ Smart phone
__ iPad
__ Laptop
__ Tablet
__ Other
Technology Integration and Application (TIA) Subscale

It is 5-point scale anchored by 1 (not at all true) to 5 (very true)

1. My course instructor knows how to use multimedia (eg, PowerPoint and animation, etc) for teaching.
2. My course instructor knows how to use web technologies (eg, teaching website, blog and distance learning) for teaching.
3. My course instructor is able to choose multimedia and web technologies that enhance his/her teaching for a specific course unit.
4. My course instructor is able to use technology to enhance our understanding and learning of lessons.
5. My course instructor is able to use technology to enrich the teaching content and materials.
6. My course instructor is able to integrate content, technology and teaching methods in his/her teaching.
7. My course instructor is able to choose diverse technologies and teaching methods for a specific course unit.

1. How did the classroom design for the Bluebox in 101 Althouse contribute to OR detract from your willingness to ask questions in class or participate in class discussions?

2. How did the classroom design for the Bluebox in 101 Althouse contribute to OR detract from your ability to stay focused during class?

3. How did the classroom design for the Bluebox in 101 Althouse contribute to OR detract from your interactions with other students?

4. Would you like to take additional courses in a classroom designed like the Bluebox in 101 Althouse? (Circle one)
   - Yes
   - No
   - Neutral/Not sure
   Why?

5. What features of the classroom, if any, made it an effective learning environment for you?

   If you could spend your time in any one part of the Bluebox space, which would you prefer:
   - ___ Soft seating
   - ___ Traditional tables and chairs
   - ___ High-top café tables and high chairs

   Why? (open-ended)
Appendix F

Student Focus Group Questions


1. How has the design of the Bluebox Classroom in 101 Althouse space impacted the way you approach learning in this subject?

2. What differences did you notice about the way you used this space this semester compared to the way you engage in learning activities in other classroom spaces?

3. To what extent have you noticed any change in the ways you interact with other students, given your experience in the Bluebox Classroom?

4. Has any aspect of the way you worked as a student in the Bluebox Classroom really stood out above all others? If so, please describe.

5. What would you add/change/remove from the Bluebox Classroom and why?