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REAL: THE TECHNOLOGY-ENABLED, ENGAGED, AND ACTIVE LEARNING CLASSROOM

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This design case highlights a new initiative, the technology-rich active learning classrooms at Michigan State University. The classrooms are intended to promote student engagement, collaborative active learning, and faculty-student interaction in a technology-rich environment that allows for digital information sharing and co-creation of content. The article describes the process of planning and design, integration of room features, and creation of user experiences.

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INTRODUCTION

Rooms for Engaged and Active Learning (REAL) are classrooms specifically designed to promote student engagement and active learning through collaborative settings and enhanced technology at Michigan State University (MSU). REAL promotes hands-on learning, collaboration between students, and interaction between faculty and students in a technology-rich learning environment. The intent of REAL classrooms is parallel to the current efforts in higher education to change the pedagogy and enhance classroom environments to support the new pedagogy of collaborative active learning (Beichner, 2007).

The Benchmarks for Effective Educational Practice established by the National Survey for Student Engagement (NSSE), a student engagement indicator used by over 800 universities in North America, clearly presents the vision of 21st century higher education ("Benchmarks of Effective Educational Practice," n.d.). These benchmarks address the importance of active and collaborative learning, student-faculty interaction, enriching educational experiences, as well as highly intellectual and creative student performance. Along with this emerging new pedagogy is an emphasis on the significant role of formal learning spaces in student learning and the need to transform traditional classrooms to a new learning environment that easily accommodates collaborative active learning in a technology-rich setting (Brooks, 2012).

The technology-rich active learning classroom model was based on the concept of the Student-Centered Active Learning Environment for Undergraduate Program (SCALE-UP) project, a research project funded by the U.S. Department of Education, the National Science Foundation, and others at North Carolina State University ("SCALE-UP," n.d.). The SCALE-UP concept was intended to provide "a highly collaborative, hands-on, computer-rich, interactive learning environment for large, introductory college courses… as an alternative to traditional lecture-oriented" courses (Beichner, 2007, p. 1). The fundamental idea was for the science disciplinary community to incorporate the studio teaching model that has been a standard mode of teaching and learning in design disciplines into the science disciplines (Beichner & Saul, 2009). Integrating the studio teaching model, the SCALE-UP concept emphasizes hands-on class activities as a main purpose of the class time instead of traditional lectures to increase student engagement and active learning. It attempts to achieve this by transforming the traditional classroom environment into a group setting with support for both low- and high-technology learning tools.

Following the concept of SCALE-UP, MSU formulated its own prototype equivalent to SCALE-UP, and started to build the first two REAL classrooms in 2012. These rooms were to be used beginning in Spring 2013. The first pilot group of faculty was selected in Spring 2012 and participated in the REAL Academy training sessions in Fall 2012, while the REAL classrooms were under construction. The training sessions focused on understanding the philosophy behind the new classroom environment and how to convert existing course formats to fit the purpose of these rooms in order to provide hands-on collaborative active learning utilizing technology in the classroom.

The authors in this article discuss the planning and creation of the REAL classrooms and focus group user experiences as representatives of four groups involved in REAL. Eric Boatman from Facilities Planning and Space Management helped coordinate the programing and design of REAL by working in consultation with the user groups, the Office of the Registrar, IT Services, and the project architect. His team also advised on furniture selection. Steve Jowett from IT Services Teaching and Learning AV & IT Integration Group was responsible for specifying and acquiring the equipment, having it installed, and maintaining it. Brendan Guenther from IT Services Teaching and Learning oversaw the faculty development and assessment programs for the REAL initiative. Young Lee was part of the REAL Academy faculty group who taught and studied user experiences from an interior design lecture course in REAL. The article especially highlights user experiences from a studio-based teaching discipline and in a relatively small class compared to large STEM (science, technology, engineering, and mathematics) courses that are typically taught in this type of technology-rich active learning classrooms (Beichner & Saul, 2009). The specific descriptions of the room in the article are from a classroom on the west side of the building, which is identical to the room on the east side of the building. The images in the article are either recreated by the first author to represent the accuracy of the final constructed rooms or by the courtesy of various parties as cited.

REAL CLASSROOM

Creation of REAL

The creation of REAL was carried out by the University Classroom Committee (UCC), a group of representatives of diverse groups at the University including IT Services, Facilities Planning & Space Management (FPSM), Infrastructure Planning and Facilities (IPF), Office of the Registrar, and faculty. FPSM was instrumental to identifying the suitable location and securing the budget; IT Services to the technology design of the rooms; IPF to construction of the rooms and installation of furniture; and Office of the Registrar to scheduling and coordination of the classes and the rooms.

The first two REAL classrooms were implemented in McDonel Hall, a residence hall at MSU. McDonel Hall is located near the east end of the MSU main campus in East Lansing, Michigan, and is one of the east side complex of residence halls called River Trail Neighborhood. The two REAL classrooms are located on the lower level of the connector wings that connects the residence wings and the central round shaped hub. Each classroom is located on the opposite side of the building, with adjacent restrooms and a central lounge area (Figure 1).

The REAL classrooms were planned as a part of the River Trail Neighborhood Engagement Center renovation at McDonel

FIGURE 1A. McDonel Hall exterior of building (courtesy of Google Earth).

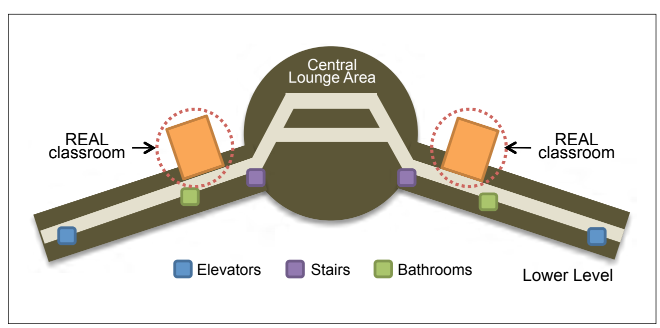


FIGURE 1B. Location of REAL classrooms in McDonel Hall.

Hall that intended to be the main access point to important resources for students in the neighborhood throughout their college education. The REAL classrooms were part of the academic area alongside the other three key areas: health and wellness, intercultural, and residential areas in the Engagement Center. The REAL classroom location was strategically selected as an opportunity to update two of the existing classrooms in the building which would enhance students' living and learning experience. In addition, it was intended to provide technology-rich collaborative active learning classrooms to the STEM-relevant disciplines who expressed an interest in this type of classroom in the neighborhood.

Design and Construction Process

The UCC made key decisions on the room features as a group. The principles that guided selection of the REAL room features included: promoting active learning, fostering collaborative learning, increasing faculty-student interaction, accommodating various learning styles, supporting different instructional formats for different disciplines, and integrating technological learning tools. Based on these principles, the UCC decided that important components of the rooms should include: flexible furniture, technology support for digital information sharing and co-creation of contents as a group, collaborative areas, both low- and high-technology learning tools, and access to power, data, and network connectivity. The development of the initial conceptual design of REAL was a collaborative effort within the UCC, which was led by FPSM. The technology design of REAL was entirely done by IT Services. Once the conceptual design of the spaces was developed, the UCC coordinated with an outsourced architectural firm for architectural drawings and services. The architectural firm contributed to determining the feasibility of the conceptual ideas and creating details of the REAL project. Since this pedagogy and type of classroom was quite new at the time, the UCC had to guide the architectural firm to successfully achieve the UCC's goals for the project.

The entire technology design of REAL was done in-house. The major technology for the classrooms comprised the use of personal laptops, group monitors, class lecture/presentation monitors, and Internet access. Embracing the rapidly growing trend of student use of personal mobile devices in classrooms, the concept of BYOD (bring your own device) was incorporated into the REAL, requiring user's own laptops instead of computers provided in the rooms. However, this posed a challenge in providing cable connectors for display of audio and visual materials from various personal laptops to external group monitors. The UCC decided to provide cable connectors for only PC computers as more students used PC computers and PC computer connectors were easier to predict than Apple Mac computers due to standardized models.

Due to the available space, the REAL room capacity accommodated only up to 60 students. The central load-bearing columns in the middle of the spaces created a challenge in settling on a seating layout around the perimeter that preserved line-of-sight between students and faculty. Since these rooms were not as large as some large-enrollment introductory courses, suitable table design and equipment options were sought for the room size. The UCC found two furniture manufacturers available at the time that produced these technology-embedded collaborative group tables. After comparing functions and costs between the products from those manufactures, the UCC decided to go with the one that provided the option of customizing tables and all necessary functions at a lower cost. The UCC decided on a truncated oval shape for the table, instead of round or rectangular shapes, to accommodate 6 students at each table with one side facing the wall.

Other challenges included predicting a variety of pedagogical approaches and user needs, and providing future-proof technology, when selecting the classroom technology. Since these types of classrooms are still in their infancy and classroom technology has been changing rapidly, a substantial amount of effort went into the planning to seek a best known approach during the process. This included a literature review, site visits to institutions that have already initiated this type of classroom, interviews with personnel involved in those projects, and inputs from various parties. The majority of research was done by FPSM and IT Services. These offices, in particular, gathered information through colleagues in the Society of College and University Planners (SCUP), the Higher Education Facilities Management Association (HEFMA), and the Learning Technologies Liaisons interest group under the Committee for Institutional Cooperation (CIC). Members of FPSM and IT Services visited the active learning classrooms at the University of Minnesota, University of Wisconsin, and University of Iowa and consulted with the project teams at these universities, while also reviewing literature to fully understand the new pedagogy and precedent cases. Due to this initial research and advance preparation, the project was finished without major issues or delays, and came out as envisioned.

Working with an outsourced architectural firm and furniture manufacturer posed another difficulty of coordinating between the services provided by the outsourced firms and the University classroom standards that required consistent systems and items for easy maintenance and user familiarity. The construction of the REAL classrooms started in June 2012. The faculty training sessions for testing the room features were held in December when those rooms were completed.

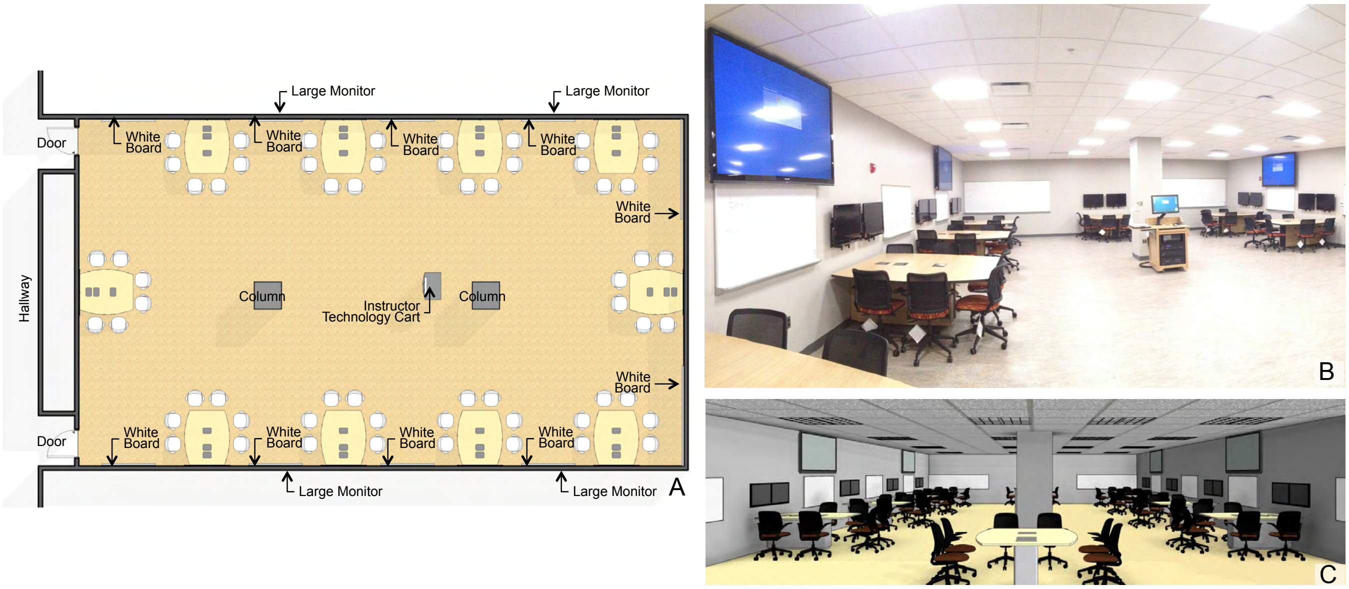


FIGURE 2A-C. REAL classroom layout. a. Floor plan. b and c. Mirrored layout of the REAL classroom (image b courtesy of MSU).

Room Features

The room features group settings for hands-on collaborative learning and enhanced technology integration for the use of digital information during class activities. The group settings include ten truncated oval-shaped group tables that seat up to six students at each table, which was suitable for the capacity of the room (Figure 2).

Each table has six mobile chairs on casters for easy collaboration among students within a group, and between other groups as well. There are four 80-inch monitors on the walls for viewing of digital information and presentations to the entire class, two on the opposite side of each wall, and a white board at each table designated for group activities. The control over the four large monitors is on the instructor's technology cart located in the middle of the room between two columns. The classroom layout was mirrored around the two columns including the locations of the doors, tables and chairs, large monitors, and white boards (Figure 2).

The technology integrated into the group tables feature easy sharing of digital information, equal contribution to generating ideas, and enhanced engagement among the group members. The table has a combination of high-definition multimedia interface (HDMI) connector cables and video graphics array (VGA) connector cables to be connected to various types of individual student PC laptops for displaying audio and visual materials from their laptops to the dual monitors installed on the wall above each table. In order to control the display of the laptop screens of different group members to the dual monitors, a technological control panel system—Crestron® touch screen—is integrated into the tabletop. The control panel has a touch screen with buttons to select which monitor and laptop to connect (Figure 3).

Once a laptop is connected to a HDMI/VGA cable, a number corresponding to the cable that the laptop is connected to is highlighted in green on the control panel. To display the laptop screen to either of the dual monitors on the wall for sharing information, the student has to press a button for either side of the monitors and the cable number corresponding to the laptop connected on the control panel (Figure 3).

Due to the incompatibility in monitor connectivity between these cables and cables for Apple Mac laptops, Mac cable adapters were not supplied in the room. Many variations of cables for different Mac laptop versions created a difficulty of supplying specific adaptors suitable to various individual Mac laptops and, thus, the supply of Mac cable adaptors was left to the individual Mac laptop owner's responsibility.

While students are given control over the display of individual student laptops at group tables for group work, there is a central control provided in the instructor technology cart for sharing and presenting of student work to the entire class. The Crestron® touch screen monitor was installed in the cart to control the sources of display input and output options. There are various sources of display inputs and outputs provided for various types of class activities and possible user needs, from the desktop installed in the cart to student group table inputs from the dual monitors in the group tables. The student group table input control in the cart allows the faculty to choose a particular group monitor to display the information on the student group monitor to other monitors in the room for sharing a particular group/student idea with the entire class (Figure 4).

The finishes of the classroom were chosen for easy maintenance, following the University classroom standards, including linoleum for floor, paint for walls, and acoustic ceiling tiles for ceiling. The color of linoleum is a combination of greyish blue and pink and the wall paint color is light grey. Typical two-lamp recessed parabolic lights are installed in the ceiling with a dimmer switch on the column near the instructor technology cart. Due to being located on the lower level, there was no access to daylight or outside views. A thermostat is provided in the room for user control of the room temperature.

USER EXPERIENCE ANALYSIS

This section of the article describes students' active learning activities in class and their focus group user experiences with the REAL classroom from an interior design senior lecture course concentrating on professional practice topics in Spring 2013. The focus group included two types of user experiences: learning experience and classroom environment experience. The focus group was composed of thirteen students who volunteered from the course. Two in-depth online surveys asking a total of 65 questions were

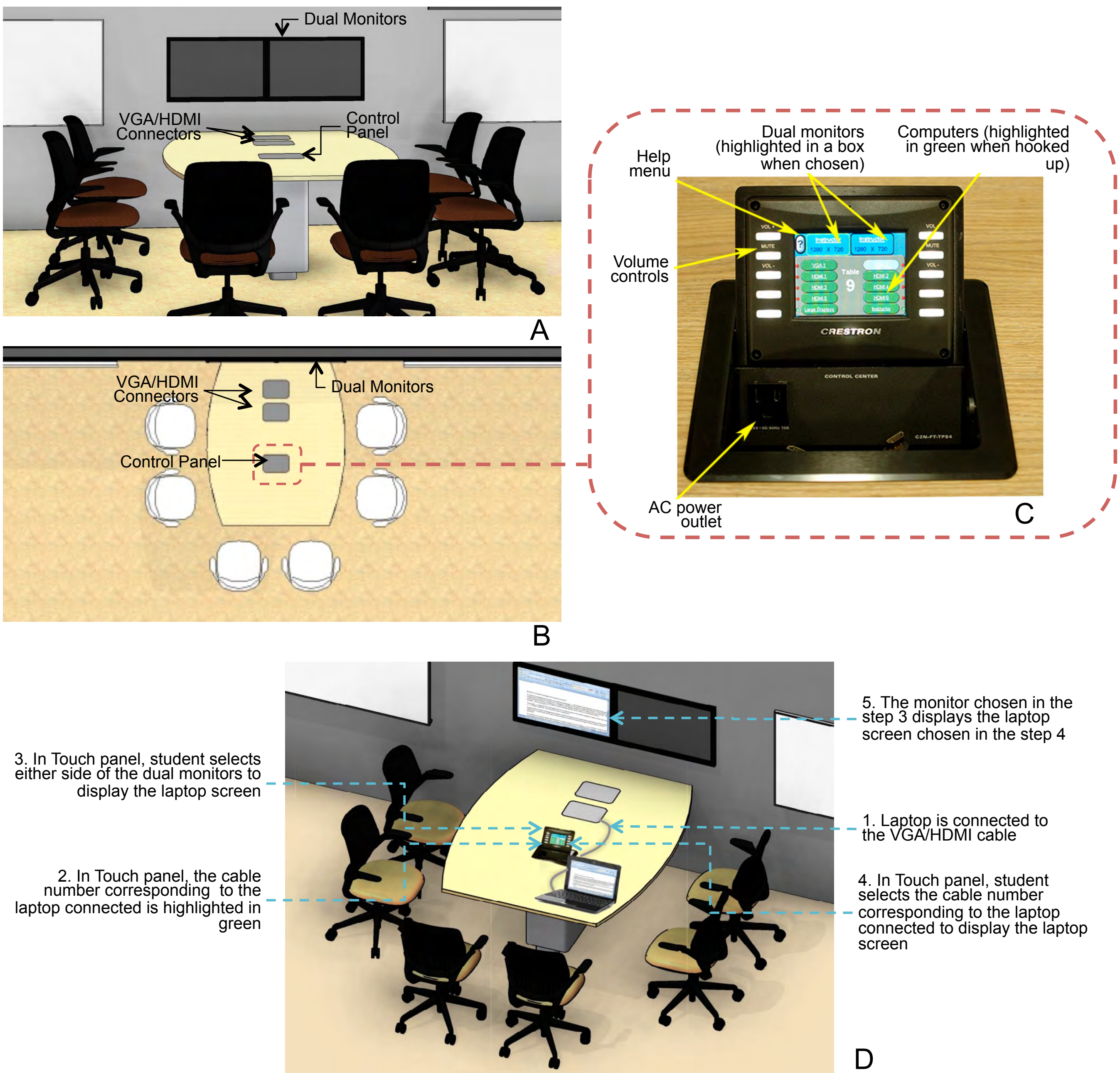


FIGURE 3A-D. Technology-integrated group table. a. Perspective view of the group table. b. Top view of the group table. c. Touch screen control panel system on the tabletop (image courtesy of MSU). d. How to display a student laptop screen to the group table monitor.

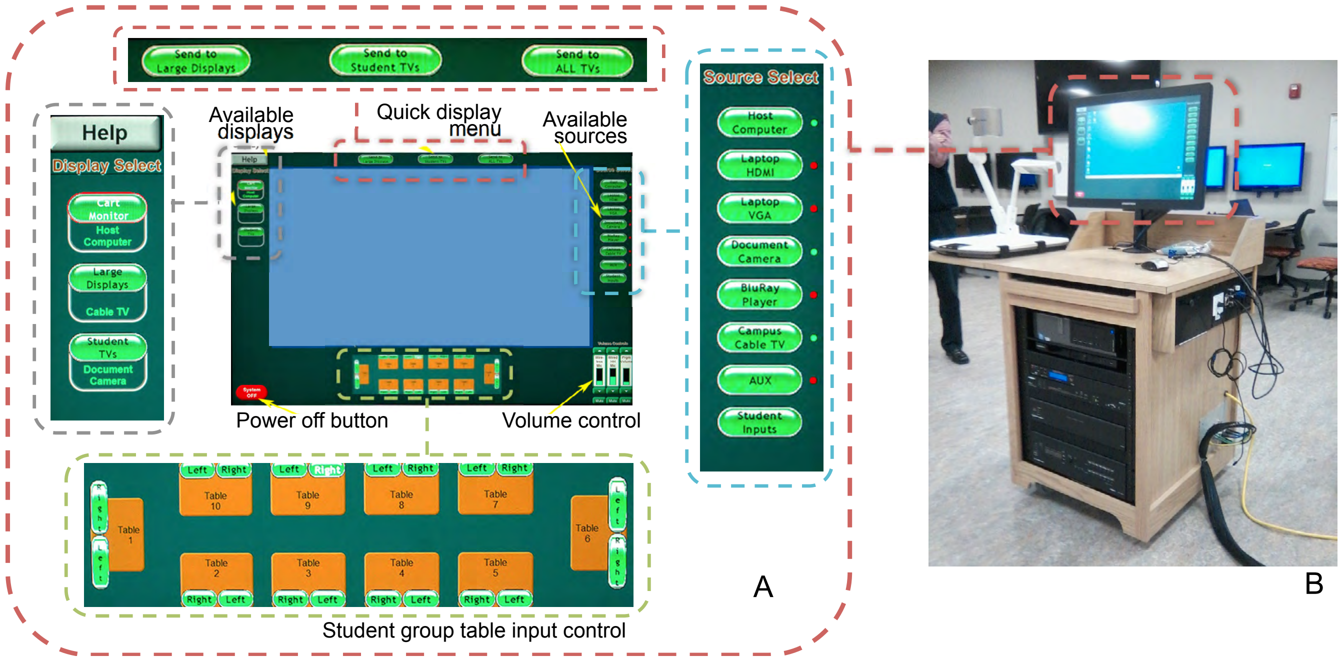


FIGURE 4A-B. The touch screen control in the instructor technology cart. a. Touch screen monitor with control for the sources of display input and output options (image courtesy of MSU). b. Instructor technology cart.

employed near the end of the semester. These surveys were used to understand their experiences with both learning and the classroom environment itself as interior design major students as well as the users of the space. There were a total of 18 students in the class. They were all seniors and female. The class met for two hours once a week. No student had any class in such a classroom as REAL prior to this class.

Active Learning in Class

The in-class activities in the interior design course, where the focus group experiences were observed, mostly consisted of group activities such as group problem-solving, presentation of ideas and solutions, small and large group discussions, and short lectures or brief check-ups of important content. The faculty member, Young Lee adopted the format of the flipped teaching model that reversed in-class activities and out-of-class activities. Traditional classes devote the majority of class time to faculty-centered lectures delivering general information. Then, students are responsible for further exploring, developing, and applying those contents on their own outside the class. In the flipped teaching model, students watch short lectures in a video format outside of class before coming to class and utilizing the class time for hands-on active learning to further build on lecture content (Wasserman, Norris, & Carr, 2013). Following the flipped teaching model, students in this course were required to watch a video lecture in advance and participate in collaborative group activities in class for student engagement and involvement (Figure 5).

Learning Experience

The survey instrument for student experience with learning came from the student survey questionnaire for learning space evaluation developed by the Research & Evaluation Team, Office of Information Technology at the University of Minnesota (Research & Evaluation Team, 2012). The original questions were regrouped to evaluate six criteria including participation, flexibility, confidence, engagement, diversity, and effective use (Table 1). Other questions that were not relevant to these criteria or the purpose of the course were excluded from the survey. The answer options for participation ranged from 1: more than once per class to 7: no participation, and for the other six criteria from 1: strongly disagree to 4: strongly agree. A total of 24 questions were asked in the learning experience survey.

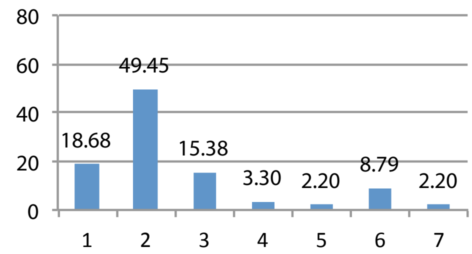
The participation criterion asked about the frequencies of student participation in class activities in seven questions including: asking questions, contributing to class discussions, explaining course concepts, working with other classmates on projects in class, completing readings before coming to the class, and discussing ideas from readings. Nearly 70% of students said that they conducted these activities at least once per class and nearly 20% of them more than once per class, which showed a high participation of students in class activities (Figure 6).

The other four learning criteria also showed positive learning experiences in the REAL classroom. 88.46% of the students concurred on the classroom's flexibility in supporting various learning styles; 80.77% on the classroom contributing to developing confidence in various tasks; 81.54% on the

FIGURE 5A-F. Various class activities. Individuals in the photos are blurred to protect their privacy.
a. Group presentation. b. Guest speaker presentation. c and d. Group problem-solving utilizing both low and high technology. e. Group ideation using the whiteboard. f. Group quiz/game.

CRITERIA	EVALUATION PURPOSE
PARTICIPATION	Student's active participation in and contribution to class activities
FLEXIBILITY	Effectiveness of the classroom in supporting various learning styles
CONFIDENCE	Effectiveness of the classroom in developing student confidence by allowing various tasks
ENGAGEMENT	Effectiveness of the classroom in promoting student commitment to learning and connection to classmates
DIVERSITY	Effectiveness of the classroom in promoting student understanding of other people's perspectives and cultures
EFFECTIVE USE	Suitable use of classroom features and class activities by the users

TABLE 1. Learning experience evaluation criteria from the questionnaire.



1 More than once per class
2 About once per class
3 Two or three times a month
4 About once a month
5 Two or three times a semester
6 About once a semester
7 Never

FIGURE 6. Student assessment of participation in class activities.

CRITERIA	Strongly Disagree	Disagree	Agree	Strongly Agree
FLEXIBILITY	3.85%	7.69%	65.38%	23.08%
CONFIDENCE	1.92%	17.31%	69.23%	11.54%
ENGAGEMENT	0.00%	20.00%	56.92%	23.08%
DIVERSITY	0.00%	23.08%	65.38%	11.54%
EFFECTIVE USE	9.23%	23.08%	55.38%	23.31%

TABLE 2. Learning experience survey results.

classroom promoting engagement; and 76.92% on the classroom increasing diversity of understanding various perspectives and cultures. 78.69% of the students acknowledged that the classroom features were effectively used as intended, which indicated that there was no misuse of the room features that might have negatively effected the learning experience (Table 2).

Classroom Environment Experience

The classroom environment experience survey was conducted to understand how various aspects of classroom environmental quality affected student learning from the user point of view. This type of survey is known as post-occupancy evaluation (POE) or facility performance evaluation (FPE) in the field of indoor built environment. The instrument came from the survey questionnaire for Indoor Environmental Quality (IEQ) Criteria affecting Occupant Performance, Health, and Well-being (PHW) developed by the first author (Lee, 2013). These IEQ criteria were identified by a systematic review of literature that either exhibited a scientific link to human performance or part of accepted standards and guidelines. The instrument considered human health and well-being as part of human performance, since these three are known to simultaneously affect one another. A total of ten criteria were evaluated with the student focus group, nine from the IEQ Criteria affecting Occupant PHW and one additional criterion specific to the REAL classroom. These nine IEQ criteria included: acoustics, layout, amount of space, furniture ergonomics, neuroaesthetics, visual comfort, thermal comfort, indoor air, and healthfulness. The additional criterion was technology, since one of the classroom features was the use of enhanced technology.

Each criterion was composed of several relevant sub items/attributes. Among the criteria, layout focused on interaction and collaboration enabled by the layout of the room settings; neuroaesthetics on neurophysiological and neuropsychological stimulation for learning from certain aesthetical elements; and healthfulness on physical health and well-being enhancing their performance achieved by healthfulness of the space. Neuroaesthetics is a field of neuroscience that explains human experience and contemplation of art on the level of the human brain (Nalbantian, 2008). Lee (2013) used the term neuroaesthetics in evaluating the impact of indoor environment on occupant performance to emphasize the growing scientific evidence of neurophysiological effects of certain aesthetic items on human performance. A total of 41 questions were asked regarding the effective level of contribution of each item or attribute of the room to their performance. The answers ranged from 1: very ineffective to 5: very effective.

Among the ten criteria, the focus group students rated layout, allowing easy interaction and collaboration, the highest (mean 4.17) and healthfulness the second highest (mean 3.90). The lowest rating was from neuroaesthetics (mean 1.62) and the second lowest rating from thermal comfort (mean 2.36) (Figure 7). While layout was rated most effective among the ten criteria, it was discovered that students thought the mobile chairs (mean 4.73) were most effective among the 41 items/attributes in the room. The layout of the room itself (mean 3.50) was not thought as effective as group tables or mobile chairs. Some students expressed that the columns in the middle of the room blocked the views at times and the distance between the two mirrored rows of group tables was too far for the size of the class.

The least effective items/attributes contributing to their learning were related to visual stimulation. Students thought

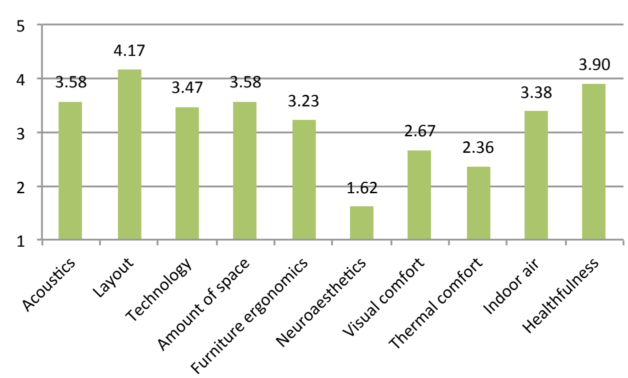


FIGURE 7. Student ratings of the classroom environment experience by IEQ criteria.

that a lack of natural elements such as no plants, daylight, and views to the outside was least effective to stimulating their learning (mean 1.23). They also thought that the finish colors of the floor (mean 1.31) and the walls (mean 1.31) were not effective in reducing visual fatigue and stimulating their learning. Some students stated that it was hard for them to perceive where the floor ended and the walls started due to very similar greyish color tones between them, and such dullness made them mentally lethargic at times.

The prevention of the reflection of glare from lighting (mean 1.92) and the room temperature (mean 1.92) were also rated as ineffective. The large monitors were installed adjacent to the ceiling lights and a great amount of reflected glare was created on those monitors. This created visual discomfort and even fatigue to those with sensitive eyes. Students frequently mentioned the uncomfortable room temperature in class throughout the semester. Sometimes, the temperature level on the room thermostat was changed by previous class members. However, some students felt uncomfortable even when the room temperature met the standards of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): the temperature range from 68-74° Fahrenheit in the winter. This uncomfortable feeling may be attributed to the seasonal change and temperature fluctuation during the spring period rather than the room temperature level itself. In addition, it may also be attributed to females being more sensitive to the indoor temperature (Hensen, 1990).

Future Implications

Following the survey results from the classroom environmental quality, groups of students held discussion sessions on what features worked best and what improvements they would like to see in the REAL classrooms in the future. They mentioned that good features of the room included technology, amount of personal and group space, use of whiteboards, open central space for gathering, and mobile chairs. Many of them mentioned that the whiteboards were great for documenting group ideas, which indicated their familiarity with manually drawing design ideas during the design ideation process as design major students. They also stated that having the various monitors in different locations was great for sharing of digital information. The improvements they would like see in the future included: the reduction of lighting glare reflection on the large monitors, new locations of large monitors, flexibility of group tables and the instructor's technology cart, and neuroaesthetic elements.

Students expressed that the lighting glare reflection on the large monitors was distracting throughout the semester. The faculty later consistently dimmed the ceiling light to 1/4~1/3 of the maximum brightness to reduce the intensity of the reflected lighting glare on the monitors whenever the class had to use those monitors for lecture, presentation, and sharing information with the entire class. When the class focused on group activities that did not need the large monitors, the light level was resumed to the normal level. Until the faculty adjusted the light level of the room, the majority of the students were not aware of the availability of the dimmer switch in the room. This led to a discussion of having an information panel next to each room feature to educate the users. This is often observed in LEED-certified (Leadership in Energy and Environmental Design; "LEED," n.d.) buildings to educate the users on green building features and promote certain user behaviors.

Students were also not certain about the location of the large monitors. They mentioned that it was hard to see the monitors from the tables below the monitors because the viewing angle was difficult, whereas viewing the monitors from across the room was too far. This led to a discussion of examining the location of the large monitors and lighting options. A possible solution to the lighting glare refection on monitors is to tilt down the angle of the monitors to avoid direct reflection. In addition, indirect lighting that lights up the ceiling and multi-zone light switches are often sought as a solution to glares (Figure 8).

The flexibility of the group tables and technology cart was also mentioned. Students mentioned that flexible and adjustable group table designs need be explored to support small breakouts within a group and different physiological needs of the users. Some students mentioned that the availability of a mobile modular system table might be good for easy reconfigurations for collaborations with other groups and diverse activities.

The majority of students mentioned that the visual stimulation and visual ergonomics could be improved by addressing neuroaesthetic elements. An appropriate level of visual stimulation, especially in use of color, is known to be important in learning environments because under-stimulated environments, such as monochromatic colors or monotonous color contrasts, can cause restlessness,

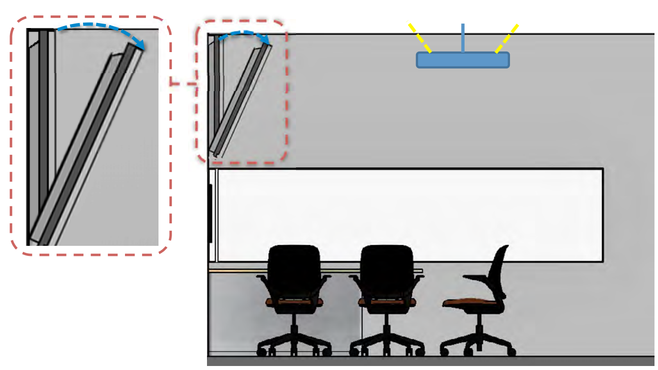


FIGURE 8. Tilting the angel of monitor and indirect lighting to reduce glare reflection.

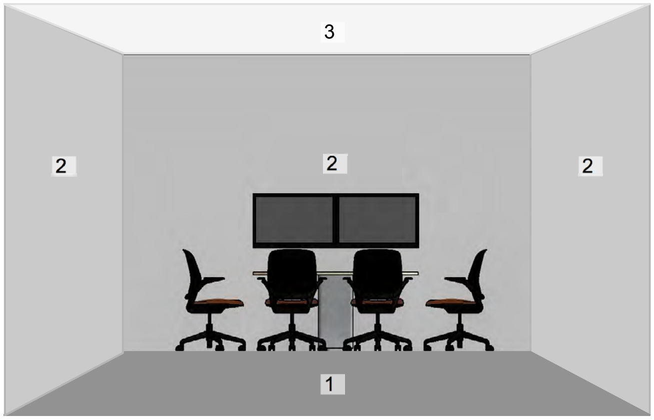


FIGURE 9. LRV ratio for room finish colors.

excessive emotional response, and difficulties in concentration (Meerwein, Rodeck, & Mahnke, 2006).

Colors also affect visual ergonomics, especially fatigue. To reduce visual fatigue, the desirable light reflectance value (LRV)—the amount of light reflected from the colors of surfaces—is a 1:3 ratio between the darkest finish color (typically floor) and the lightest finish color (typically ceiling) (Mahnke, 1996). The use of lighter colors has recently been encouraged in educational facilities due to energy efficiency since lighter colors reflect more light into the space. However, it may be necessary to seek the desirable LRV ratio among the finish colors for visual comfort and productivity (Figure 9).

In an open ended question regarding the course fit and the room, many students pointed out that the room was too big for the size of the class and did not allow the users to achieve the intent of the room to the full extent. This may be addressed by looking into the studio space layout solutions in design disciplines. For instance, to provide a flexibility of combining classes or opening studio classrooms for critiques, some studio classrooms are divided by the floor-to-ceiling movable partitions with acoustic panels in the School of Planning, Design, and Construction at MSU (Figure 10). While this may require more instructor technology carts in the space, it can provide a flexibility of holding various sizes of classes in the space simultaneously, allowing each class to be held in a properly sized room.

CONCLUSION

This case showed that the REAL classroom was effective when used with a small class from a studio teaching-based discipline. The REAL increased student participation in class and promoted more ownership of students' own learning as seen in the results. While technology-rich collaborative active learning classrooms are meant, in general, to serve large-enrollment introductory courses in STEM disciplines, various majors may also benefit from such classrooms. This is because the typical lecture format can be an ineffective learning method that puts the majority of students into a passive mode of learning across various disciplines.

However, the overall impact and effectiveness of this type of classroom still needs to be proven across various disciplines and courses to justify the cost and the size of spaces associated with REAL. REAL classrooms, in particular, consume more space than traditional classrooms. REAL classrooms are typically planned at about 30 square feet (SF) per student, while traditional classrooms are in the neighborhood of 20-25 SF per student. It is hard to predict what the overall impact of this might be at the moment. However, REAL is an evolving project that will undergo further refinement and enhancement as more user feedback is available and more reliable data will be obtained in the near future.

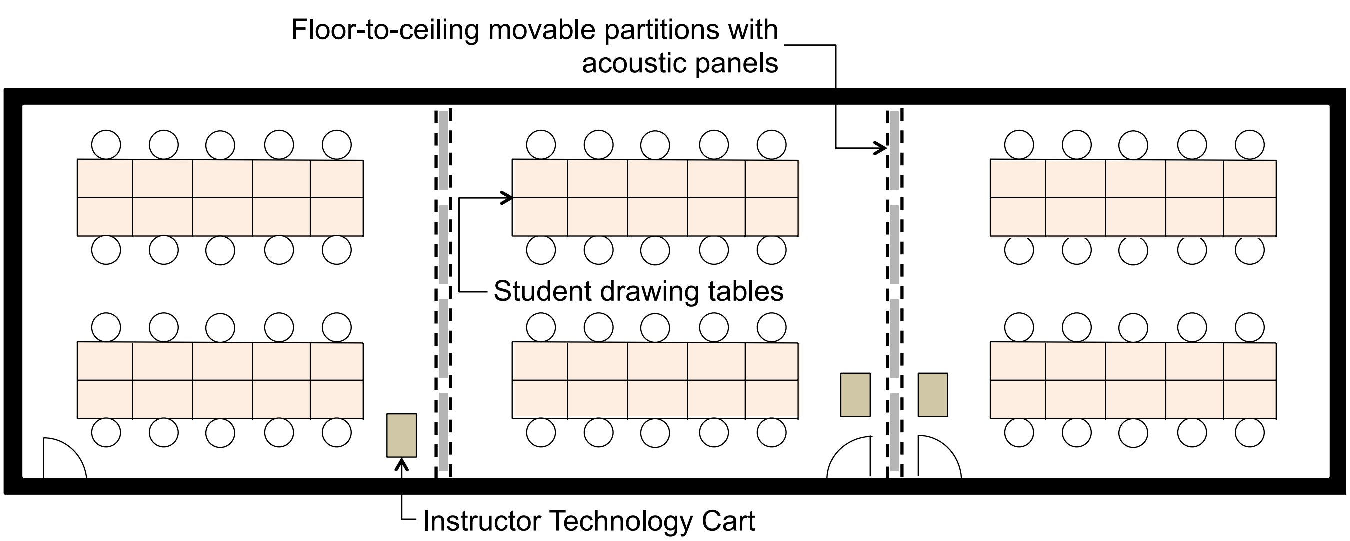


FIGURE 10. Flexible studio classroom layout used for design courses at MSU.

As MSU plans more REAL classrooms for the campus in the coming years, some changes will follow and further discussions will evolve to accommodate diverse user needs and different disciplinary requests. The changes that are currently being considered include: rooms of smaller and larger capacity, varying levels of flexibility, incorporation of different colors and finishes, and equipment for differently shaped rooms such as microphones. As an on-going effort, FPSM and the Office of the Provost led a brainstorming session for active learning classrooms with regional experts in Fall 2013. In addition, faculty development and instructional methods will be enhanced to integrate a higher level of student collaboration and co-creation of knowledge. As the initial cohorts of faculty gain experience teaching in these spaces, they may contribute to future REAL Academy sessions. It is important to encourage and monitor faculty commitment and enthusiasm in completing the REAL Academy training and restructuring their courses to take advantage of this type of classrooms. A way to balance between summative assessment and formative assessment may need to be sought to enhance faculty development in the future. Summative assessment in this case seeks to decide if the person is making good use of the room and should be allowed to use the room again. Formative assessment seeks to help them improve their practice to make best use of the room. As there are a limited number of REAL classrooms available, a system may be needed to implement summative and formative assessments for faculty development.

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