A DESIGN CASE EXAMINING LEARNING IN THE D-LAB

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The design process described in this case emphasizes decisions made to guide and direct the creation of a unique classroom addressing the needs of millennial learners. The project, a research/learning partnership with Herman Miller, gained insights from participants in a design charrette, an advisory group focused on creativity, and the practice, teaching, and research experiences of the project leadership. The challenge was to create a learning space that encouraged behaviors and activities to enhance creativity for today's millennial learners. Decisions made during the design process were shaped by the perspectives of faculty and student users, whose comments were documented in exit interviews and annual teaching evaluation questionnaires. Despite a minimal budget, the project demonstrates how careful planning through ideation, strategic partnerships, and implementation took the design from *wishful thinking* to full execution and implementation. The resulting classroom is the case's outcome and the design processes' response to the needs of academic spaces that invite millennial learning.

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CONTEXT OF THE CHALLENGE

The Interior Design program at Colorado State University is housed within the Department of Design and Merchandising. The program offers a four-year Council for Interior Design Accreditation (CIDA) Bachelor of Science in Interior Design and a post professional two-year Master of Science in Design and Merchandising.

The authors of this design case are faculty members teaching in the program and members of an informal research group focused on creativity. The project lead has been a faculty member in the department for 12 years and was responsible for assembling the design team and overseeing the project's implementation, from start to finish.

This design case presents the design process and outcomes of a learning space—a design lab or *d-lab*—expressly designed to address the learning styles of millennial learners.

A campus tour guide described the Interior Design program's location, in a building originally constructed as a campus dormitory in the 1950s, as "the most unaesthetic environment on campus." Over the past three decades, no one could recall any significant renovation, although the classroom had been painted pink, blue, and brown, fabric covered tack surfaces had replaced warped homosote painted panels, and metal stools had replaced broken upholstered drafting stools. Physical support for the objectives of a creative major and program remained elusive. We searched for ways to improve the environment, desiring to model the program's learning spaces after design practice workplaces to invite students to experience the environment of the profession while in school.

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This classroom, used primarily by third and fourth year students, had been cited for “underutilization” by the campus committee responsible for classroom use and scheduling. At the same time, classes scheduled in this space required simultaneous use and scheduling of a computer lab. The classroom, equipped with large drafting tables, presented a severely outdated environment that did not support student learning. Content taught in this classroom relied heavily on technology for projects and assignments; hand drafting had not been used in the upper level studios for over ten years to document project-based ideas and solutions.

Faculty, long aware of the dysfunctional qualities and affordances of this classroom, exhausted diverse avenues for sources of funding in order to acquire furniture to enhance the technology-based major and offer a creative and collaborative environment. Prior program accreditation visits had focused attention on the positive attributes of the space, including access to daylight and adjacency to computing facilities, but site visitors informally shared perceptions of the need for more appropriate work tables and seating. Classes held in this room required students to be seated on metal

stools to work at drafting tables for three to four hour class sessions.

We as faculty were further frustrated by a lack of social place in the building, forcing students to camp out along narrow hallways, sitting on terrazzo floors to wait for the prior class to vacate the classroom. Adding to this frustration was the teaching of content exemplifying design excellence in a space far from exemplary standards of design by any small measure.

Faculty, along with the institution, had also observed a shift in the student profile—to students savvy with technology as the norm, preferring to learn from diverse sources rather than a teacher-centric learning model, and seeking greater socialization and transparency in their learning environment. These traits documented in the literature as those of the millennial generation were creating a schism in the ways we were taught to teach and expect student learning.

At the same time, interior design students and faculty were being utilized as a resource by the university’s facilities department and by other departments on campus to create and develop design solutions for lounges, classrooms, and

FIGURE 1. Existing front classroom with drafting surfaces and stools.

FIGURE 2. Existing rear classroom with large tables.

FIGURE 3. Existing classroom plan.

diverse building projects around the campus. These projects had received funding from alumni, friends, donors and the university; why not Interior Design?!

The process shaping what would become the *d*-lab began as a response to student disappointment. New furnishings were not forthcoming following a decision to fund remediation of lead paint in another on-going project led by the University's Facilities group. Had it been funded, this new furniture would have replaced large and cumbersome 3'X 4' high drafting tables with metal stools (Figure 1) and large flat tables (Figure 2) currently located in two studio classrooms used by interior design students and faculty (Figure 3).

DESIGN INTERVENTION + DEVELOPMENT

The story of our design process and some external influences that shaped the *d*-lab will be related here referring to Best's (as cited in Lockwood, 2010, pp. 150-151) 5-step innovation process (Figure 4).

Step 1: immersion + understanding

A decade of informal and formal observations by the project faculty focused on student work habits, styles, and limitations during problem solving.

FIGURE 4. Best's innovation process used in the creation of the *d*-lab (Adapted from Lockwood, 2010).

Program space needs, reflected in faculty and student requests for changes, repeatedly identified the lack of informal space where students could work or hang out between formal classes, meet as teams for project assignments, or just eat and relax. For example, faculty and students had a hard time entering or leaving the classroom with students sitting or standing in the hallway, and the rear classroom area (Figure 2) was perceived by students as a dark and uninviting place, and a dismal place to eat food. In this area the tables were so large that moving them required substantial strength and ingenuity.

Another problem was space usage. Space limitations required a "hot seat" studio structure—when a formal class was over, students left the program area to scatter across the campus or sat on the outside patio or grassy area in nicer weather because other students would need the classroom area. At semester's close, students would also begin camping out in the classroom, running extension cords across the studio floor to plug in laptops in one of four outlets. Furthermore, students would post hand-made signs over their work in progress to ask that project work not be disturbed or moved. Students would place models and projects on work surfaces in the corners of the studio, hoping that faculty would not ask them to "move their stuff out."

Step 2: discovery + opportunity

The faculty opted to pursue providing a better space to the students. Two different avenues presented themselves. First, the College of Health and Human Sciences' (CHHS) Development Director suggested we seek funding through university facilities fees. Secondly, the project lead discovered the potential for a new partnership between the department and the Herman Miller

Learning Spaces Research Project. These were initially considered as separate entities, but these two opportunities merged as they were shaped by funding possibilities.

In fall 2011, students continued to vocalize their disappointment about the furniture and visibility of the interior design program, and student contributions to space development in other areas of campus brought these issues to a head. The project lead partnered with another faculty member to teach an experimental course on design process and presentation and we decided to respond to student concerns by developing solutions for a design gallery close to the location of the current *d*-lab. This project focused on increasing visibility of the work undertaken by the students in the major and providing space that could be used for socialization. Three student proposals were presented to the CHHS's development team in hopes of attracting potential donor attention. During this meeting, the development director planted the seed that eventually led to ideas for project funding—she suggested we take our ideas to the University Facilities Fee Advisory Board (UFFAB). UFFAB was responsible for guidance and advice concerning use of the University Facility Fee and reviewed all project proposals of facility improvements that directly benefit CSU students.

Simultaneously, in an informal conversation with a Herman Miller furniture company representative during a class visit, the project lead shared the need for appropriate furnishings and unearthed the next key breakthrough in bringing the idea of the *d*-lab to fulfillment. She explored the potential for the Herman Miller Learning Spaces Research Project (LSRP) to provide a research-based framework and obtain new furnishings for the classroom. The LSRP collaborates with universities across North America to test new approaches to learning spaces. Initially, it appeared an investment of \$15,000 by CSU would confirm participation in the project, and enrich the research of faculty examining the relationship of creativity and the physical environment.

The project lead developed preliminary plans (Figures 5 and 6) for an IDea Pod, a student lounge and coffee spot located between the targeted classroom and computer lab, which was heavily trafficked by students from diverse majors in the college. The goal was to increase visibility and exchange of ideas and provide access to hot drinks, a point of contention for students. The project was presented to the dean of CHHS by the department head as a prime target for differential tuition funds. The dean set aside \$15,000 for the project with the stipulation that a funding match was obtained. Herman Miller helped the project lead identify the level of funding necessary to create each design option (Figures 5-7). The dean's allocation created the opportunity to confirm that the college endorsed the idea with UFFAB. This endorsed CSU's participation in the Herman Miller project.

Step 3: creating a vision

Design thinking efforts started small and the project lead focused initially on the informal socialization needs of students with the development of the IDea Pod as a place to get coffee and carry out small group exchanges. The vision for the Gallery and IDea Pod as a student lounge/coffee spot merged when we evaluated funding and cost realities. When the faculty team realized the potential to request monies to significantly renovate the classroom environment and purchase furniture for the entire project, they expanded the plans. With expansion of the project scope and inclusion of the adjacent computer lab in the funding request, the project required engagement of diverse partners to solidify the vision and create the kind of space needed.

Step 2 described an initial idea called the Gallery Project. This project, while tangentially addressing the need for informal socialization space, represented considerable cost by challenging the building's structural integrity. The Gallery did not address students waiting for access to classrooms or the computer lab and did not necessarily encourage interactions and cross-disciplinary idea pollination with interior design students and other majors using the computer lab and adjacent classrooms. The proposal for the IDea Pod student lounge renovation, affiliated with the Herman Miller initiative, clearly embodied the socialization and informal space needs identified by students. Students from the experimental class who had originally developed the Gallery idea volunteered to help present both proposals to UFFAB—for the gallery and the classroom. Armed with sketches and animations of possible space use and student support, the project lead and several students from the class presented both the Gallery and IDea Pod proposals to UFFAB. It was unclear how much money UFFAB might consider for the projects and what evidence they needed to make their decision. Unfortunately, the projects were met with mild interest and tabled for future consideration.

In spring 2012, both proposals for the Gallery and classroom were again invited to be on the UFFAB agenda. The team learned that awards made during the fall cycle had requested significantly more funding (e.g., funding entire buildings). With this news, a little voice said to the faculty project lead, think bigger! In light of this, when the Budget Opinion (BO) estimate for the Gallery came in at over a million dollars, twice the cost of what was presented in the fall, the project lead made the decision to:

- withdraw the Gallery project;
- expand the coffee spot;
- include the needs of the classroom; and,
- package this request with the renovation of an adjacent computer lab.

One area of concern was the BOs that were required when presenting to UFFAB encompassing the classroom and IDea Pod, totaling \$163,769.79. The BO's had been based on very

FIGURE 5. Idea Pod proposal (option 1).

FIGURE 6. Idea Pod proposal (option 2).

FIGURES 5-7. Sequence of schematic plan proposals presented for funding (5, 6); expanded to include the entire learning environment (7) and using the existing classroom and underutilized adjacent spaces for the coffee spot.

preliminary and inaccurate information regarding affordances and amenities to be incorporated into the expanded plan (Figure 7) with potential to significantly impact project feasibility. With no time to create a new BO for the combined project and to avoid losing the dean's financial match and an opportunity to present to UFFAB, the team moved forward with these early cost estimates after re-evaluating the combined estimates. An initiated conversation with the Facilities Project Manager revealed he felt the project scope could be refined when construction documents were being developed and that the stated cost of \$65 per square foot should be adequate to achieve the plan. Certain items including the carpeting and electrical master system for a key card access system were covered in the computer lab portion of the funding.

FIGURE 7. A second proposal for the classroom and lounge, where the entrance to the computer lab remains adjacent to the classroom.

The request made by the project lead and college Information Technology (IT) Director for \$385,000 met with success, with the assistance of supporting BOs for the initial IDEa Pod, classroom, and computer lab. The project was funded in May 2012 with the classroom portion receiving the additional funding of \$15,000 from the dean. During the presentation, the two projects were separated at the request of the IT Director. The computer lab, disengaged from the classroom, was not included in the partnership with Herman Miller.

Step 4: validation with key stakeholders

Planning ideas were vetted through the efforts of a design charrette with participants in the partnership including leading design practitioners, faculty, undergraduate and graduate students, and campus constituencies. Ideas generated from the charrette were translated by the faculty project lead into six plan options reviewed by the Creativity Research Group (CRG), an informal research team comprised of faculty and graduate students from three universities. This group is engaged in research and publication surrounding theoretical and applied work in creativity. This led to the creation of a best fit plan by the project lead.

Now, the serious business of aligning the dream with projected costs would begin! Getting from the schematic proposal (Figure 7) to a final plan solution (Figure 8) created an opportunity to engage diverse stakeholders to ensure every idea was explored and evaluated against every dollar to drive the core objectives of the project—creating a collaborative space enhancing creativity for millennial learners.

In the contractual agreement with Herman Miller, the project lead created formal alliances with Interior Design faculty and students, representatives from across the campus including Facilities, Academic Computing and Network Services, The Institute for Learning and Teaching (TILT), and design practitioners. With funding received at the end of the spring semester, multiple activities energized this process. The project lead worked over the summer to:

- conceptualize and organize a design charrette;
- meet with the CRG to review research findings against planning ideas;
- develop the final plan;
- conduct product research and specifications;
- select the furniture and finishes;
- coordinate the final furniture order;
- identify the technology requirements and evaluate products;
- coordinate decisions with construction document process;
- submit data collection protocols for Human Subjects approval, required to collect and publish findings, using pre and post surveys and a focus group question outline;
- review and redline three iterations of construction documents prior to bidding;
- research lighting selection and confirm calculations; and
- coordinate with Facilities and the external construction project managers.

The first step was finalizing a plan engaging and involving key stakeholders. The idea behind holding the charrette was to explore diverse ideas using a design thinking methodology, holistically addressing the needs of the students and space. After all, this would be our only chance to test ideas underpinned by theory and practice experience insights. For the project lead, this process offered a rare opportunity to bring practice, teaching, and research full circle.

At the conclusion of spring semester exams, the charrette was organized and held in the classroom to be renovated. Participants were invited based on their creative reputations in practice, in the classroom, and on the campus. At the start of the four-hour activity, the project lead gave background information on the space and creative behaviors the project hoped to achieve, then the group discussed student and faculty concerns and desires. Three teams were formed;

each led by a design practitioner with representatives from each constituency. The teams measured, conceptualized, and visualized ideas capturing a wide variety of planning approaches (e.g., holistic approach or top down, exploring form or specific elements such as technology). Mini charrettes from team members then assembled key ideas, and examined functional interfaces. The team outcomes of the charrette evidenced ideas for collaboration, socialization, accessibility, technology, and learning models. These ideas were then translated by the project lead into six conceptual plan solutions.

The CRG reviewed each plan against a check list of creativity and collaborative characteristics derived from their research activities. They then made recommendations on strengths and weaknesses evidenced in each plan, which led to the selection of plan elements assimilated by the project lead into the final plan.

This checklist identified behavioral and physical qualities enhancing creativity. These included elements that would:

- Effect critical thinking and questioning
- Enhance problem solving
- Improve and enhance collaboration and networking
- Promote leading by influence
- Promote initiative and entrepreneurship
- Invite access and analysis of information
- Promote and enhance oral and written communication
- Increase curiosity and imagination
- Invite the ability to see diverse aspects of a problem (integrative thinking)
- Develop multiple perspectives (empathy)
- Promote ideas no matter how challenging the solution (optimism)
- Explore a process of trial and error using new and creative ways (experimentation);
- Increase associative capabilities
- Maximize observation

To finalize the plan, the project lead also considered learning attributes incorporating the needs of the student population, which was comprised of 70% millennials on the CSU campus. This added another layer of functionality to the plan that led to important design inclusions:

- Transparency achieved through visual and acoustical “access” to activities;
- Direct connections to the exterior, with card key access and tables/chair located on the interior of the exterior wall
- Program branding through spatial aesthetics
- Enhanced interconnectivity and socialization spaces inviting collaboration;
- Improved acuity with high performing lighting fixtures appropriate for diverse work activities

- Maximized technology using two 60" LED screens and a Barco share system allowing up to four laptops to be simultaneously connected and additional electrical access for powering laptops and other plug-ins
- Variety in learning modalities supporting informal socialization, formal socialization, instructed learning, team/project areas, and a research/resource area
- Environmental duality enhancing the work/play dichotomy (i.e., "do what you love")
- Spatial plasticity through the movability of furnishings with caster and locking mechanism on work surfaces
- Enhanced risk-taking increased by physical comfort impacting conceptualization and design thinking
- Diminished territoriality by allowing greater choice for behavioral parameters and reduction in boundaries
- Modeling the environment of professional practice in interior design adding to student self-esteem and public recognition

Final Adjustments: Identifying and Prioritizing Furniture

The final plan (Figure 8) underwent a concluding iteration, with Herman Miller defining actual furniture selections and pricing in parallel with the project budget and behavioral and physical criteria identified. This resulted in minor modifications and adjustments.

A critical decision point, however, occurred at this juncture. Generally furniture and finish budgets, as the last to be "spent," suffer cost reductions. The success of the project was in no small way dependent upon the choice of furniture to achieve certain behaviors and promote utilization linked to these behaviors. If the project was supported by only furnishings and no change was made to the shell of the space, the project could still achieve a majority of desired behavioral responses with respect to the evidence of learning outcomes—that is, getting work done on projects and assignments. However, if the furniture budget were decreased, the project could fail and the drafting tables and stools might just as well remain. Creating a line item for furniture made it possible to separate costs allocated for furnishings vs. construction at the beginning of the project. This strategy ensured that these costs were adequate to cover the purchase of the furniture. It further insinuated that, therefore, the purchase of the furniture was a priority. The furniture costs were validated ahead of construction and ordered in July, out of sequence with the construction schedule and stored on site during construction. This decision by the project lead eliminated the opportunity to access project funds for construction. However, this also required the project lead to confirm both furniture and construction costs on a daily basis with project construction administration to avoid costly mistakes during the construction phase.

FIGURE 8. Final space plan.

Buy-in from all participants involved in the construction was also a key component resulting in a minimal punch list at the conclusion of the project.

Because the project was in actuality similar to outfitting a science lab, CSU Purchasing and Grants & Contracts worked together to expediently approve the purchase order; the furniture was treated as research equipment by university purchasing as the "equipment required to conduct the research experiment." This was no small task, as they had never had furniture identified as an expense for research of this magnitude. In addition, the furniture had to be specific to Herman Miller and not 50% from knock-off (i.e., alternative product companies) provided by a state vendor, as required by university policy.

Final Adjustments: Color Palette

Finish selection was another milestone decision impacting the classroom color scheme. Generally a color scheme reinforcing the concept is the approach taken by designers, but in this case, color and finishes had to be selected from somewhat limited ranges. An objective of the project was to eliminate the existing colors that lent an oppressive feeling to the space and was deemed by students to be residential in its aesthetic. The goal of transforming the classroom into a professional yet neutral background for color-laden project displays invited a timeless approach to aesthetics. The first challenge came with carpet selection. The proposed coffee spot area, having served as a gallery, had gray carpeted benches proposed to be reused as seating. Matching carpet to existing material resulted in selection of a Milliken carpet tile, more costly than the norm provided on campus projects but essential in developing a professional color palette for

the space. Color is very subjective; therefore, the project incorporated color primarily on walls and some furnishings enhancing the ability to change out color over time. The selection of fabrics and surface materials required the project lead to develop a scheme addressing the carpet selection against what was available in the budget; this resulted in gray and white used in the most active area of the studio, orange as a back-drop for research and team areas creating warmth during long periods of sitting, and spring green for the lounge and coffee spot inviting relaxation.

Step 5: integration + activation

The final phase for the d-lab design process involved construction documents generation and also highlighted opportunities for cost savings in materials and assemblies. A creative approach to the construction process was used by Facilities Small Projects Manager, by awarding the bid to an outside general contractor but extracting the electrical and demolition work so that it was done in-house. The work was completed in 30 days over the winter break, ready for students returning to classes for the spring semester.

Challenges still weighed heavily as the first sledgehammers hit the masonry walls of the corridor. Perhaps indicative of working within an academic institution were phrases heard almost daily from construction and university staff: “that’s not the way we do it here” or “that can’t be done.” Some examples included:

- The decision-making surrounding a 7’0” pivot door that would control access from the coffee spot to the collaborative lounge was a challenge for the contractor who could only envision a standard door opening. Their patience and ingenuity created a successful divider demonstrating where there’s a will there’s a way.
- The technology the project lead described to produce collaborative viewing of computer screens caused the technology team to shake their heads until they saw a product that actually did allow four different views to be shown at the same time. They later shared they didn’t know what was being described, but when testing this new system, they saw great value in sharing this progressive system with other university units. The IT partner on the project team voiced a newly evolved appreciation and pride for the project lead’s being at the edge of innovation. This system is regarded by faculty and students as having made the biggest impact on the teaching learning experience in the d-lab.
- The goal was to reflect a contemporary aesthetic but to do so in a cost effective way. Reaching out to a former student and lighting design practitioner helped create a lighting solution that positively impacted the selection of fixtures for the learning and lounge areas.

Several critical challenges during construction surfaced. For example, after construction had started the project lead was presented with a budget shortfall when carpet was added to the d-lab construction budget, originally funded from the budget for the computer lab renovation. The lead discussed with senior students the trade-offs of carpeting vs. new lighting, generating ideas for obtaining lighting at a later date. This resulted in a decision to eliminate the proposed lighting selection. The project lead ultimately opted to capitalize on the campus’s desire to provide for greater energy efficiency. The project lead brought the shortfall dilemma to the attention of the VP of Administrative Services on these terms, resulting in an expedited request to UFFAB for an additional allocation of \$24,000. Funding was awarded eliminating the need to make a very detrimental trade-off that would have significantly impacted the functional and aesthetic qualities of the space.

Tradeoffs were continually balanced against needs supporting student learning. For example, existing tack surfaces were re-used and blackout curtains on clerestory windows were eliminated. When the electricians realized that project aesthetics were integral with learning objectives, they began making suggestions to improve the final installation. This attitude began to prevail from carpet installers to painters, and pride in the work accomplished was evident during site visits by the project lead.

Reactions to Construction and the Completed Space

The studio had been emptied in May with expectations construction would begin when the spring semester ended; however, as project reviews commenced, the studio sat vacant through summer and then fall. This visible lull in progress disheartened some students. After students left on winter break, construction began and continued at a rapid pace. In mid-January 2013, senior students began dropping by the site to see if the studio had changed. Their response to the almost completed environment reflected the majority of student reactions when school began—from speechless jaw-dropping to “unbelievable, I want to live here.”

At the prompting of students, each second through fourth year student signed a code of conduct vetted by student organization leaders making them the responsible party for damages. Students began self-policing the space when they moved in from the very first day of classes as non-design students began infiltrating the studio when the opportunity presented itself. When they discovered the space, students from other majors were actually surprised to find that it was new classroom space for interior design; they commented to the Provost there should be more spaces like this on campus.

LEARNING EVALUATION AND OUTCOMES

Two focus groups conducted by faculty project partners and the project lead engaged seniors in a discussion of the

effects of the space on their learning near the end of the semester. While certain outcomes were expected, several surfaced reflecting and emphasizing millennial perspectives the project lead had not anticipated.

Hierarchy vs. Accountability

The reduction of hierarchy in the classroom with faculty sitting “with and among” students during class discussions and presentations re-focused the purpose of assignments toward content and lessened the meeting of presumed faculty expectations. This enriched the depth of preparation by an individual or team. Students perceived faculty as facilitators and resources to learning, with accountability up to them. One student commented, with faculty sitting right next to you, “You can’t use your cell phone.” Faculty did in fact note cell phones ceased to be used during class sessions.

Socialization

Students positively commented about the latte machine installed in the coffee spot and usage was high, according to the campus vending office. The \$1 a cup price proved a great value. Students began using the coffee spot for club meetings, team projects, and for conversations with faculty, peers, and friends. The coffee spot’s popularity was certainly enhanced by the latte machine, but other measures of socialization were indicated in student comments about the *d*-lab:

- the ability to choose where to work;
- the inability to sit in the same seat in class; the furniture was mobile and invited students to sit in different locations, making new friends throughout the semester; and
- students in different years promoted idea exchanges, something found to be very challenging before the creation of the *d*-lab environment.

One need not met when the space was occupied was a microwave for student use. With a contribution from the project’s construction/project management firm, a microwave and cart were installed in the coffee spot as well as a credit card swipe for the latte machine. This caused much student excitement as they began the fall semester.

Technology

The project forced re-use of existing tack panels, the primary presentation format prior to the lab opening. However, the run of panels was inadequate for the larger space resulting from the renovation, forcing faculty with students to re-consider presentation approaches. The move to technology-supported presentations was a crucial learning lesson for faculty and students. Use of the LED screens for project presentations set the stage for one of the biggest surprises

for faculty and students related to the use of image sharing software.

The Barco Clickshare dongle system for PC and Mac users allowed for multiple users to load their content on the screens and view up to four screens simultaneously, providing rapid and seamless transitions between presentations as well as the opportunity to expand the viewing field to look at project detail. Faculty commented on the change from viewing projects singularly to viewing the same work on LED screens. Initially the faculty design team thought it would take more time, but in fact Clickshare technology has allowed for time to be more appropriately used, moving from people tacking up their work to plugging in a project on a laptop using a dongle. Four students were prepared to present at once, so when something didn’t work, faculty could move forward with an alternate presenter. The quality of the screen image is not affected by daylighting levels, making viewing projects even more enticing.

The addition of overhead electrical pulleys in the ceiling above the studio area allowed powering of batteries and plug in opportunities, avoiding laptop shut downs in the midst of a presentation. The intimacy created by these presentations was also noted by students as a factor enhancing their focus on the information being presented (Figures 9 and 10).

This university does not require students to have laptops, yet many students bring their personal laptops or utilize the laptop check-out program to work in the *d*-lab. During a meeting with student leaders organizing a program event, the group noted in the midst of the activity they were all working at their laptops, interacting with ideas, which was not at all a possibility during the previous semester!

Security vs. Access

Increased feelings of ownership were evident as students took it upon themselves to clean the tabletops and pick up trash after a student meeting or activity. Third and fourth year majors in the program expressed increasing disappointment as the semester progressed regarding lack of policing by second year students in monitoring who entered the lab and cleanliness of tables surfaces.

As student use of the space increased, an unforeseen conflict surfaced between enabling direct views to the outside patio area and the “fishbowl” effect occurring at night when the large windows exposed the central learning area. Students talked about screens and other barriers for nighttime use but did not want to lose access to daylight during the day. The current solution when working individually appears to be locating one’s work area in the team and collaborative lounges space where lighting levels also support detail work.

FIGURE 9. Teaching with technology, shifting the hierarchical boundaries of teaching-learning in the collaborative lounge.

FIGURE 10. The studio area with natural light, moveable tables and chairs, moveable white boards, overhead electrical plugs; team area behind the orange moveable screen, with whiteboards on rear of screens.

Another unforeseen conflict surfaced in terms of accessing the studio. With a need to maintain after hour access and security for students, a card reader was installed at the exterior door to the *d*-lab. Despite Colorado's relatively pleasant daily climate, students did not want to walk 15 feet along the exterior covered patio during the daytime. As a result, students began to prop open an interior side door entrance to the lab, increasing the uneasiness of many female students as non-majors began to access the space. Random students could be found sleeping on the sofas, working on laptops, gluing paper in the café, eating lunch in the team area, and in general invading the classroom, thinking it was a new student lounge even during class times! The trashcan holding open the door became a wooden wedge as janitorial staff attempted to help out with access. A request to install touchpad combination hardware has been made to allow users access to the space for their classes.

Enhancing Creativity

Support for creativity, from the students' point of view, included the ability to control and shape their environment to the task at hand. The physical space provided choice of where to sit, opportunities to configure the furniture to particular needs, color schemes to soothe or stimulate, with carpeting and casters for quiet movement in the space. Faculty note these qualities eliminated barriers to creativity and innovative thinking. The creation of the studio itself demonstrated dreams could become a reality. Several times students mentioned the elimination of barriers within the context of comfort. For example, the space allowed them to sit in different positions, and access a latte or hot chocolate from the coffee spot without breaking their train of thought. While the space was large, the differentiation of space eliminated boredom while working (Figures 11-13).

One important objective of the project was to create a space emulating the professional work place. Faculty note that perceptions of professionalism and a clearer understanding of practice activity have become apparent as students begin to draw comparisons of the space to their internship work places and other practice environments they have visited.

The color scheme has been described by students as bright and energizing with "colors not too overwhelming but stimulating energy flow," while challenging the assumptions of classrooms as dull, static, and boring. In the *d*-lab, color plays an

FIGURE 11. The collaborative lounge with LED screens, pivot door to the coffee spot.

FIGURE 12. Team research pods with research and resource library.

FIGURE 13. Students interacting at the coffee spot.

important role beyond dividing functional spaces or zones; color challenged the notion of what is a classroom.

STUDENT AND FACULTY PERCEPTIONS ON THE IMPACT ON LEARNING

This design case exposes and demonstrates the use of a framework for the creation of this learning space. The development of this space moves beyond earlier conceptions of spaces adopted by some universities to facilitate active learning (e.g., the flipped classroom initiated by Jonathan Bergmann and Aaron Sams in Colorado, and the SCALE-UP approach initiated by Robert Beichner at North Carolina State) by addressing behavioral needs for learning that engage and invite, model learning through learning activity, and allow for the learning needs of the millennial generation. Mindful control in the space, a decreased delineation of boundaries with access to cutting edge technology, and responsiveness to social networking have enhanced the faculty and student experiences in facilitating active learning.

Students noted changes in the way they had previously worked. They packed more equipment and food, and made sure they had their IDs in hand to avoid being locked out so that they could stay for longer periods of time in the classroom. When asked for descriptions of more traditional classrooms, students used adjectives including “formal,” “desks in rows,” “static,” “rigid,” “one-sided,” “lecture structure,” and “boring.” In stark contrast, the new learning studio was described by the students as a friendly environment making students want to come to the studio, exemplified in their pride when showing family and friends the place where they “live” at school.

Faculty have perceived students and themselves to be more engaged in teaching and learning, perhaps through the diminishment of a teacher-centric environment in favor of a more facilitated environment desired by millennials. The space adapts as students and faculty engage in the design process, reducing stressors and frustration in getting work done. The faculty team senses the *d*-lab has proven to be an effective response to diverse types of learning, from lecture to project oriented classes. It doesn't look like a classroom, but quality learning is taking place.

CONCLUSION

This design case as a precedent for designers offers detailed descriptions of the decisions and influences afforded in the process of creating the *d*-lab. The impact of this learning environment, however, is dynamic and continues to be felt as students occupy the classroom in this next school year. New discoveries in the way the space is used are afforded by the flexibility of the furniture and lighting controls; table and chair locations, documented on a weekly basis, are never found in the same spot for long. Perhaps the most significant impact of the case is in university administration's interest in using this learning environment as a prototype to address the challenges of lecture classes across STEM disciplines and the millennial learner's desire for spaces that adapt to their needs for greater interaction. The elimination of the teacher centric focus of the past in post-secondary education opens the door to diverse learning modes, dramatically impacting campus planning in the future and blurring the meaning of what we know as the “classroom.”

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