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Making Peace with the Rising Costs of Writing Technologies: Flexible Classroom Design as a Sustainable Solution

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Abstract

In a challenging economy where budgets for academic programs seem to shrink each year, writing programs face serious economic challenges. When fiscal challenges are paired with the ever-changing nature of writing technologies and the need to update classroom technologies on a regular basis, the challenges can seem insurmountable. In this article the authors discuss the multiple phases of a classroom redesign project where first-year composition students used their own laptop computers in a flexible classroom, which included mobile furnishings, mobile whiteboards, and multiple LCD screens for projection. The purpose of the project was to design a space that was economically sustainable and would better meet the needs of composition instructors and students. To meet that goal, the First-Year Writing Program partnered with the institution's IT and Design Services to develop the flexible classroom model. The flexible classroom project sought to answer the question: how do we take existing classroom spaces and small/shrinking budgets and make the spaces work well for the teaching of writing? Based on financial comparisons of equipment between the flexible classroom versus classrooms where computers are provided by the university, as well as student surveys, the authors found that a flexible design is a cost-effective solution that is also an effective pedagogical space.

Keywords: Classroom design; Flexible design; Economic sustainability

1. A point of conflict

Over the last two decades, computer classrooms have slowly begun to replace non-technologically enhanced classrooms at many colleges and universities as the default environment for writing instruction. At our large public university in the southeast, writing program administrators fought for several years to move all of the first-year writing classes into computer classrooms to give students and teachers access to technologies for writing. We used several tactics to achieve that goal, including repurposing older furnishings and technologies that were not ideally suited to teaching writing to augment the start-up funds that were available but couldn't cover the cost of outfitting new computer classrooms. Some classes met in rooms reserved for first-year writing that were equipped with desktop computers while others had laptop computers; we used the available technology and furnishings we could find. We were able to retrofit two classrooms with desktop computers and four classrooms with laptop computers to accommodate the 225 sections of first-year writing taught each year.

Initially, teachers operated on a rotation schedule so that every writing class had the chance to be in a computer classroom at some point during the week because we could not afford to equip enough computer classrooms for

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all sections of first-year writing. The rotation schedule was limiting for faculty, however, and they found they were designing their course calendars around what days they would have access to technology instead of what pace would be most beneficial for students. Additionally, technology in the classrooms quickly became dated. Maintenance of existing university-owned desktop and laptop computers is expensive, and we quickly realized that the victory in securing start-up funding for computer classrooms was only half the battle.

Recently, the IT specialists at our college presented a new challenge: we needed to replace the computers in our 4 laptop classrooms soon. These classrooms had fixed tables arranged in 4 pods around the perimeter of the room with 5–6 laptops at each pod (first-year writing classes are capped at 22 students). The laptops had originally been intended to lend some mobility to the classroom, but the frequency with which laptops disappeared from the classrooms prompted IT to tether the laptops to the tables. The laptops were still more desirable than desktop computers, however, because they improved sightlines in the classroom (in comparison with the large monitors in our two desktop computer classrooms that blocked visibility), and instructors could ask students to close the laptops for class discussion. But because they were tethered to the tables, students could not move computers around the classroom, and the laptops could not be removed from the tables when not in use.

The cost of replacing the laptops, without even updating or repairing any of the furnishings in the room, seemed astronomical: $20,700 to replace 23 computers in each lab, plus $800 to replace the teacher's desktop computer at the front of the room. The total cost for 4 classrooms would be $86,000. The cost was only slightly less per room for our 2 desktop computer classrooms, which also needed updating: $17,600 to replace 23 computers (not including the cost of monitors), plus $800 to replace the teacher's desktop computer. In total, the minimum cost for updating the technology in our 6 computer classrooms would total $122,800. In a department where over 90% of our budget is devoted to personnel costs, that amount of money was equivalent to the cost of staffing 23 sections of first-year writing. We clearly couldn't cancel 23 sections and leave over 500 students without a section of first-year writing in the coming year.

Eleven years into a curriculum that moved us into computer classrooms, we found ourselves at a stalemate. We needed to make a decision—and quickly—about how to update our computer classrooms economically, or we needed to change our approach to teaching writing altogether. We found that we faced three problems, and only one of them was fiscal in nature. First, the cost of updating our computer classrooms and continuing to teach as we had been was economically impossible. Second, the rotation schedule we had built for our computer classrooms was cumbersome for teachers and confusing for students. And third, an increasing number of our students wanted to bring their own computers to class rather than use the computers in the classroom, but our classrooms weren't designed to allow for that flexibility. The laptops tethered to the tables in our classrooms took up much of the available table space for student technology, and the desktop computers took up all of the available table space in the desktop classrooms. Additionally, students couldn't access power outlets in the classrooms because the outlets were moved under the tables so that students had to crawl underneath the tables to access them. This decision was made because students were unplugging the university-owned computers to plug in their own technology without shutting the university computers off, draining batteries for later classes.

We clearly needed to deploy new tactics, and we needed a new approach for maintaining technology in our classrooms. We needed to make peace with the cost of teaching with technology by finding a sustainable solution for our students, our teachers, and our IT specialists.

2. Preliminary strategies

Our first solution was to design a computer classroom where students were invited to "bring your own technology" (BYOT). On the surface, it seemed to address all three problems. Instead of replacing all of the laptops, we could replace a small number (1–2 per class) for checkout by students who temporarily needed to use a laptop for class. Because our institution does not require students to purchase laptops, we limited enrollment in these sections to students who agreed to provide their own technology. Therefore, the BYOT classrooms were not an ideal fiscal solution; we still needed to maintain our original computer classrooms for students who did not have access to mobile technology, and we were concerned about isolating students who did not have their own laptops. BYOT classes resolved our second problem, however, because the rotation schedule could be phased out. We repurposed our non-computer classrooms as BYOT classrooms, eliminating the need to rotate in and out of computer classrooms. Finally, a move to BYOT classes solved the third problem because students who wanted to bring their own technology were not only able to, but

they were encouraged to do so. We designed the classroom to provide plenty of tabletop space for student technology with power access at every student seat. The classrooms used tables in the same configuration we had used in the laptop classrooms, arranged in pods around the classroom next to fixed outlets with power strips. The soaring costs of maintenance, cumbersome rotation schedules, and students' preferences for their own technology were all partially or completely remedied with the move to BYOT classrooms.

As we piloted the BYOT classrooms, we found two problems remained. We were still maintaining our computer classrooms for students without laptops, so our fiscal dilemma persisted. A new problem emerged; teachers were becoming increasingly frustrated with the inability to rearrange the BYOT classrooms. Even though students were bringing mobile technology to the BYOT classrooms, the tables were heavy and fixed, arranged next to power supplies. The mobility of the students' technology paired with the fixed nature of the classroom furnishings highlighted the disconnect between our classroom design and the pedagogical approaches our teachers wanted to be able to use.

When we interviewed teachers who taught in the pilot BYOT classroom, several mentioned a lack of connection with the students in the class, attributed to the way the room was arranged and fixed. One instructor mentioned that she felt she was "missing some type of connection" she could have with her students. Eye contact was limited with some students in the pod arrangement because their backs were to the front of the classroom. Turning around meant they would not have access to a tabletop. Another instructor mentioned that she avoided whole class discussions because students seemed to get very distracted and because "the organization of the room doesn't really lend itself to that very well... so many of the students had their backs to each other." Instead, she reported relying on small-group activities and limiting full-class discussions. Instructors, overall, seemed happy with the technology solution for students, but they found the arrangement of the classroom problematic. The design of the room simply wasn't flexible enough to allow instructors to rearrange it for a range of writing activities.

We began to find that our computer and BYOT classrooms had an even more fixed design than our old, non-technologically-enhanced classrooms. In classrooms without computers, students often sat in tablet-arm chairs that could be circled and moved around the classroom into different configurations. In computer classrooms, the technology tethered us (sometimes literally) to a specific classroom design.

We began to entertain the idea of designing flexible classrooms with mobile furnishings where students could bring their own technology. The factors we needed to consider in classroom design that previously seemed to pull our resources in opposite directions came together. We wondered if we could connect:

- research on effective learning space design
- sustainable planning
- economic feasibility, and
- student and teacher preferences

Finally, we found ourselves fighting a battle we thought we could win.

3. Designing a plan of attack

Scholarly discussion of instructional environments for writing tends to focus on the modalities of instruction and the approaches that are most pedagogically effective in a variety of mediated learning environments, but scholars in rhetoric and composition have begun calling for more attention to the design of physical spaces. In "Hacking Spaces: Place as Interface," Douglas M. Walls, Scott Schopieray, and Dánielle Nicole DeVoss (2009) wrote that scholars in computers and writing have focused on issues of space related to software, access, virtual space, and physical design. However, they argued, "Physical space is perhaps one of the most important, yet often overlooked, issues of interface that we negotiate as writers, researchers, and teachers" (2009, p. 273). Christian Weisser and Sidney I. Dobrin (2001) also emphasized the importance of attention to place in composition studies and argued, "Discourse does not begin in the self, as some expressivist theories and pedagogies have erroneously suggested; rather, writing begins externally in location" (p. 8). Place, space, and location are certainly important factors for us to consider as we study writing and technologies of writing.

Nedra Reynolds (1998) argued for the importance of attention to place even earlier, writing that "Place does matter; surroundings do have an effect on learning or attitudes towards learning, and material spaces have a political edge" (p. 13). Reynolds continued to remind us in 2004 in *Geographies of Writing: Inhabiting Places and Encountering*

Difference that we should not ignore the physicality and materiality of learning environments, asserting that "*places* are hugely important to learning processes and to acts of writing because the kinds of spaces we occupy determine, to some extent, the kinds of work we can do or the types of artifacts we can create" (p. 157). Ed Nagelhout and Glenn Blalock (2004) echoed this concern with the relationship between physical space/design and classroom activity, writing that classrooms "situate students in specific physical spaces, constraining or restraining the movement of students and teachers" (p. 135).

Ruth M. Mirtz (2004) has also noted that the design of the classroom, its movement and lack of movement, are "physical manifestations of power" (p. 14) for both teacher and student. Drawing on her experience as a composition teacher and writing program director, Mirtz argued that instructors (consciously or unconsciously) use the placement of desks and chairs to establish authority and control, while students use the same furnishings to control their engagement in class (p. 19). Movement in a learning space is directly tied to thought and ignoring this idea "is to ignore movement's ability to foster new relationships, which can lead to critical thinking" (p. 21) and, by extension, more thoughtful, productive writing. Complicating this dynamic is the potential for some students to be excluded from discussion by virtue of spatial design. For example, a handicapped-accessible desk, while providing a space to participate in the class, might also isolate a student if it is immovable or irregularly shaped in comparison with other desks. Our challenge is, as Thomas D. Skill and Brian A. Young (2003) described, "to design learning spaces that do not simply accommodate the need for diverse learning approaches but embrace, empower, and sustain learners of differing capabilities and interests" (p. 24). Learning spaces should first be designed, after all, with human well-being in mind (Scott-Webber, 2004; Gee, 2005; Chism, 2009). Clearly, the concerns of the teachers in the BYOT classrooms at our institution were well-founded; the constraints they felt by the fixed design of their classrooms paralleled the conclusions of scholars in the field.

We began to consider how we could design a classroom that would draw on current research on place, space, and classroom design that would also be sustainable and economically feasible. Flexible classroom design seemed to provide an answer; flexibility would allow us to accommodate a variety of classroom activities and types of writing while also addressing the preferences of students and teachers. Additionally, the BYOT design we had already experimented with had proven to be more economically feasible than designing computer classrooms/labs. We hypothesized that a careful, flexible design could also promote sustainability by being adaptable to new technologies for writing that students might bring to the classroom. We had a plan of attack, but a "flexible classroom" could take many forms. We needed to refine our plan based on best practices in instructional technology and writing classroom design.

Other scholars have specifically addressed the physical characteristics of the learning space itself. Kenneth A. Bruffee (1998) has argued that writing is about conversing with others and that these conversations happen best in collaborative groups. Classroom spaces should support this kind of interaction, yet they frequently do not. Educators should "resist the traditional mindset in educational architecture" (Bruffee, 1998, p. 260), which is the usual lecture hall with fixed desks or an immobile computer lab. The traditional computer lab layout (with fixed desktop computers in rows) "is a barrier to conversation and collaboration" (p. 260); for conversations about writing to take place with ease, both students and teachers must be able to move freely about the space. Bruffee would likely agree with Amanda Metz Bemer, Ryan M. Moeller, and Cheryl E. Ball (2009), who have written that traditional computer labs may limit collaboration, while the material conditions of a "mobile" computer lab (furnished with laptop computers and modular furnishings) can be viewed as "affordances to collaboration" (p. 140). For example, desktop computers with sizable towers or monitors can create unwanted visual barriers that interfere with students' sightlines (Bemer, Moeller, & Ball, 2009; Bruffee, 1998; Hochman & Palmquist, 2009). Moreover, lab layouts where the computers are configured in rows with a teacher's station at the front of the room support a hierarchical pedagogy and the one-way transmission of knowledge from teacher to student (Handa, 1993). Changing the physical environment to support collaborative pedagogies (such as peer review groups), has the ability to change the social structure of the classroom, which in turn "changes the nature of the authority the teacher exercises" (Bruffee, 1998, p. 69). Other composition scholars have also noted that furnishings and equipment can influence social relationships in the classroom (Kent-Drury, 1998; Meeks, 2004). Furnishings not only have ergonomic concerns but are also a "maker of power dynamics" (Meeks, 2004, n.p.). The physical design of a computer classroom has the ability to influence the relationships students have with each other and the kinds of work that take place within the space itself (Bemer et al., 2009).

We found Will Hochman and Mike Palmquist's (2009) study of wireless laptop computer use in composition classrooms particularly compelling, supporting Bruffee's ideas as they reported that students' use of laptops gives instructors greater physical flexibility. Their research suggested that "ergonomic factors enhanced contact between

students and instructors, supported collaboration among students, and reduced the extent to which, in comparison with desktop classrooms, the technology dominates the classroom space" (p. 127). Along with Bruffee, Walls, Schopieray, and DeVoss (2009) see computers in rows, as well as fixed infrastructure, as issues in teaching and learning in these environments. The authors offer suggestions for working in these challenging spaces, such as assigning students to smaller groups and having them work around one computer. Melissa Graham Meeks (2004) has also addressed the importance of the physical learning environment based on her experience in teaching in a laptop classroom, and she encouraged instructors to defy the initial set-up of the classroom.

Bruffee's call to resist traditional educational architecture, Meeks' appeal to defy the classroom layout, and Walls et al.'s ideas on "hacking" the computer lab space all demonstrate that composition teachers "have a rich tradition of subverting classroom design" (Bemer et al., 2009) in order to facilitate discussion and peer review in writing classes. Freedom of movement and flexibility in design are important factors for both effective collaboration and effective use of technologies for writing. Our teachers had demonstrated this same resolve, working around the design of both our computer classrooms and our new BYOT classrooms to facilitate the kinds of activities that they felt were important for writing classes. We saw an opportunity to design affordable, sustainable classrooms that are also flexible enough to support best practices instead of acting as a barrier to them. Such classes meant lower costs for us in the long run and important economic consideration for institutions of higher education.

To assist us in the redesign of one of our BYOT classrooms, we turned to published empirical studies conducted in the emerging field of learning spaces. In particular, the "studio" classroom design, which is typically characterized by movable furniture, wireless computing and projection, and wall space for the sharing of work, is employed "almost exclusively by science, math and engineering courses" (Taylor, 2008, p. 218). Robert J. Beichner, Jeffrey M. Saul, David S. Abbot et al. (2007) have researched the effects of active learning classroom design on physics education through the development of the Student-Centered Active Learning Environment for Upside-down Pedagogies (SCALE-UP) Learning Initiative. The SCALE-UP model is designed to promote the formation of learning communities through a technology-rich, studio environment. Active learning is encouraged through a hands-on pedagogy (that is, not lecture), as well as the physical design of the space, which includes nine-person round tables, LCD monitors and white boards on the walls, and no formal classroom "front." Results from empirical studies of the SCALE-UP model have shown a number of positive findings, including reduced failure rates for women, minorities, and other "at risk" populations, and an overall increase for students in their conceptual understanding of the material. The SCALE-UP model was adopted and adapted at MIT, and the researchers concluded that the social interactions between the students played a key role in knowledge-building. The findings also indicated that students made statistically significant improvements in understanding concepts compared to those students taught in a traditional lecture class (Dori & Belcher, 2005).

The SCALE-UP design was still fixed, however, which did not address the concern that our instructors had about how fixed furnishings were impacting their pedagogical options in the classroom. We looked, therefore, to other empirical studies that reported on more flexible designs. Summer Smith Taylor (2008) examined the effect of classroom space on instructor's pedagogy in Astronomy and Genetics courses. Unlike the fixed furnishings in the studies above, the studio classroom in Taylor's study was characterized by light-weight chairs and tables that could be easily rearranged. Taylor's research revealed that the faculty members teaching in the studio space incorporated active learning strategies into their courses to a degree; the instructors reported that the space itself was a catalyst to their adoption of an active learning pedagogy, which they believed encouraged more class discussion, collaboration, and communication between students. Taylor (2008) concluded this "indicates that even teachers who are not inclined towards active learning pedagogy can be enticed by studio space to incorporate such pedagogy into their classes" (p. 233). While we hypothesized that writing instructors in our program were already inclined to use active learning approaches, we were encouraged by the possibility of such a design facilitating collaborative activities.

The results from several studies on active learning/flexible classrooms have also indicated a relationship between the design of the classroom on whether instructors perceive their relationships with students as more egalitarian (Taylor, 2008) and more equitable (Dittoe, 2002). Additionally, Aimee L. Whiteside, Linda Jorn, Ann Hill Duin, and Steve Fitzgerald (2009) reported a correlation between flexible classroom design and instructors perceiving a change in their role from that of teacher to facilitator or coach (Whiteside et al., 2009). These findings support the arguments made by composition scholars Erika Lindemann (2001) and Mirtz (2004) regarding the power relationships suggested by a classroom layout. These studies suggest that power dynamics between the instructor and students can be impacted by the learning space and the kinds of pedagogy practiced within it. Sawyer Hunley and Molly Schaller (2009) wrote that students in their study reported feeling less responsibility to participate in a traditional classroom (with the instructor

positioned at the front); as a result, they concluded that student engagement is more profound when students are situated in a learning space where they "hold ownership" (p. 34); in addition, they reported that "noninteractive pedagogies" hindered academic engagement (2006, p. 13.9).

4. Developing alliances

We chose to launch a modified, flexible BYOT classroom, still facilitating students' use of their own technology and allowing them to compose in class with technology with which they're familiar and which they would use beyond the writing classroom. The classroom was designed, however, to be more conducive than our fixed classrooms to experimenting with collaborative pedagogical approaches and new technologies through its flexible design. Such a classroom was a more efficient use of our limited budget, which could then be used to provide powerful resources to support and augment student-owned technology through innovations such as checkout computers, multiple LCD screens, moveable white boards, and moveable furniture.

To develop and effectively launch such a design, we needed to build strategic alliances with partners in our program, department, college, and university. While the initial buy-in for the plan was relatively easy to gain from allies in the writing program, especially the instructors who had enjoyed teaching in the fixed BYOT classrooms but longed for a more flexible design, we needed support—both through budget and infrastructure—to make our classroom design a reality. We began by crafting a brief proposal for the project to present to our department head, who needed to approve classroom space for the project and to support requests for funding from the college and university. As part of our proposal, we described the research design we would implement to collect data that could support a grant proposal to extend the project beyond an initial pilot classroom, and with our department head's blessing, we took this plan to our Dean. We also talked to our college information technology team, who designed the technological infrastructure and support and introduced us to university-level administrators who could help with classroom modifications and equipment purchasing. The university architect/classroom designer became an integral part of the process through her connections with furniture suppliers and her interest in the research focus of the project. By bringing all of these strategic partners to the table from the beginning, we were able to build a design and research team with invaluable experience and connections we would not have had on our own.

Our Department Head, Dean, and IT Director worked together to find initial funding to get the project off the ground, to include the purchasing of furniture and technology for the newly designed classroom (exact costs are outlined in the next section). Design of the classroom took one semester, working with the IT staff to change the wiring and install new technology and with the University Architect who ordered furniture for the classroom. Because of the experimental nature of the classroom as a pilot where we would collect data to determine how to expand in the future, we chose to place three different types of movable desks in the classroom. We also decided to purchase six mobile whiteboards for the classroom and five LCD displays, which were installed around the perimeter of the classroom, to see how students and instructors would use the technology to collaborate. These innovations increased the baseline cost of the classroom, but they allowed us to collect valuable data that would help us determine the most productive and cost-effective way to expand in the future.

As we designed and implemented the pilot classroom, we systematically measured both the cost of launching such a classroom design (especially in comparison with the cost of updating and maintaining our existing computer classrooms) and the effectiveness of such a space as reported by students' perceptions of the classroom. For a long time, the administration of the writing program had assumed computer classrooms with provided computers in various configurations were the ideal environment for teaching writing, but through this study we began to collect empirical data that tested that assumption.

5. Counting costs

The initial baseline costs of implementing the four different classroom designs discussed in this article (desktop computer classroom, laptop computer classroom, fixed BYOT classroom, and flexible BYOT classroom) are outlined in Table 1.

Not surprisingly, the most expensive classroom design was our laptop computer classroom. That the fixed BYOT classroom design was more expensive than a desktop computer classroom was an unexpected finding. The primary reason for this expense was the furniture cost of the fixed BYOT classroom (tables and chairs designed for a room

Table 1
Initial Baseline Costs for Classrooms Designed for 22 Students.

	Desktop Computer Classroom	Laptop Computer Classroom	Fixed BYOT Classroom	Flexible BYOT Classroom
Computers	$17,600	$20,700	N/A	N/A
Tables	N/A	N/A	$3,870	N/A
Chairs	N/A	N/A	$8,800	$400
Mobile Tablet-Arm Chairs	N/A	N/A	N/A	$8,250
ADA Desk	N/A	N/A	$550	$550
Electrical	N/A	N/A	$4,500	$4,500
Teacher's Computer	$800	$800	$800	$800
Total Cost	$18,400	$21,500	$18,520	$14,500

where students would have access to power and space to spread out their laptops and materials). In our discussion with university administration, we did not include costs for furniture in either of the two types of computer classrooms because the furniture was already purchased and installed, but both of the BYOT designs required purchasing new furnishings. The computer classroom figures report the cost of updating the technology in the rooms, while the BYOT classroom figures report the cost of designing new classrooms to support a BYOT approach in either a fixed or flexible environment.

In an instructional environment without desktop and laptop classrooms already in place, we would have needed to include the cost of furniture in an estimate. The furniture costs would be similar to the fixed BYOT classroom, making the comparison even more striking, as seen in Table 2.

As we compared the baseline costs of the four classroom designs, we also considered that the technology costs in all four environments would be recurring costs since the computers would need to be upgraded periodically. These costs included the teachers' computers (in all classrooms) as well as the students' computers (in the computer classrooms only). The furniture costs in the BYOT classrooms, however, were one-time costs. With this information in mind, the initial baseline cost of the flexible BYOT classroom was remarkably affordable. Not only was it the least expensive initial classroom design, but (along with the fixed BYOT classroom) it required the lowest ongoing cost for maintaining the classroom over time.

In addition to the baseline setup costs, we also incurred several other costs while implementing our pilot flexible BYOT classroom:

- **Checkout computers**: The BYOT classrooms required the maintenance of a small group of checkout computers for students who needed the use of a computer on a temporary basis. Currently, we only allow students to check out a computer to replace a machine that is temporarily being serviced or replaced. We already had a fleet of about a half dozen laptops for our fixed BYOT classrooms (total cost, approximately $5,400). We considered the need to expand the size of the checkout laptop fleet should we eventually convert all of our classrooms to a BYOT setup. In such a case, we would likely need to change our checkout policy to include students who do not own a laptop and might need to check out a computer for the semester or for every class period.

Table 2
Initial Baseline Cost with Furniture Purchases for All Classrooms.

	Desktop Computer Classroom	Laptop Computer Classroom	Fixed BYOT Classroom	Flexible BYOT Classroom
Computers	$17,600	$20,700	N/A	N/A
Tables	$3,870	$3,870	$3,870	N/A
Chairs	$8,800	$8,800	$8,800	$400
Mobile Tablet-Arm Chairs	N/A	N/A	N/A	$8,250
ADA Desk	$550	$550	$550	$550
Electrical	N/A	N/A	$4,500	$4,500
Teacher's Computer	$800	$800	$800	$800
Total Cost	$31,620	$34,720	$18,520	$14,500

Table 3
Student Room Preferences.

If you had to sign up again for ENG 101, would you prefer a room like T126, which has mobile furnishings and LCD displays or a more traditional room where the furniture doesn't move? (N=195)		
I would prefer T126	152	78%
I would prefer a more traditional room	9	5%
It doesn't matter what room I'm in	34	17%

- **LCD projectors**: We purchased and installed 5 LCD projectors around the perimeter of the pilot classroom to see how teachers and students might use the technology and how the use of such technology might impact the collaborative nature of the classroom. The LCD displays cost $1,500 each, for a total cost of $7,500. Reviews of the LCD projectors were mixed, with students reporting that they found the technology useful, but with teachers reporting that students did not use the LCD screens for collaboration as much as they used other forms of technology, such as mobile whiteboards.
- **Mobile whiteboards**: We also purchased six mobile whiteboards for the classroom that could be moved around the room to support collaboration and a variety of classroom activities. While the mobile whiteboards aren't a necessary part of the flexible classroom design, the students and teachers used them a great deal. Informally, teachers commented that the whiteboards were the most useful technology in the classroom. At a cost of $728.50 each, they were also the least expensive technology in the classroom. The whiteboards were such a popular innovation that we are looking into purchasing them for all of our writing classrooms, flexible or not.

Although our flexible BYOT classroom design included several other optional features that raised the final cost of the classroom, we found that the $6,500 difference between updating a laptop classroom and implementing a flexible BYOT classroom helped to cover those costs. Additionally, not all of the costs are recurring (such as the checkout laptops, which are shared between classrooms), and some might be minimized in future classrooms (such as the perimeter LCD screens, which seemed inconclusively useful).

Ultimately, the difference in cost between upgrading our 6 computer classrooms (2 desktop classrooms and 4 laptop classrooms: $122,800) or converting them to flexible BYOT classrooms (6 classrooms: $90,000) was $32,800. Additionally, the long-term cost would be considerably less because we would not have to pay to upgrade all of the computers after 4–5 years. Although we knew that we wouldn't be able to find a solution that was free, the cost savings was considerable. Before making the jump, though, we needed to measure the effectiveness of the classroom design.

6. Measuring impact

One of the primary ways that we measured the impact of the flexible classroom design was through a student survey administered in all sections of first-year writing offered in our pilot classroom. We received 195 responses to the survey (approximately 80% of the students enrolled in classes in the pilot classroom), and 2 of the questions offered specific information about student satisfaction with the design itself.

One question indicated students' preference for a flexible classroom design or a more traditional, fixed classroom design (Table 3).

Over three quarters of the students who responded to the survey preferred the design of our flexible BYOT classroom to a more traditional, fixed design. Only 5% of respondents preferred a more fixed design, while 17% indicated the design of the classroom did not matter to them. We did not sort students' survey responses based on the specific section of first-year writing in which they were enrolled. In a future study, it might be interesting to see whether students' preferences for a particular classroom design cluster according to the which class they are enrolled in and whether their responses to the classroom design correlate with their teacher's pedagogical choices and/or enthusiasm for the design.

We also did not ask students to elaborate on their reasons for their preferences in that question, but we did ask a separate question that asked students to rate how the design of the classroom contributed to their learning (Table 4).

Nearly two-thirds (66%) of respondents indicated that the design of the classroom had some relationship to their learning, while only 34% indicated that they either felt neutral about the relationship or that the design of the classroom did not contribute to their learning at all.

Table 4
Students' Perception of How Classroom Design Contributes to Learning.

Rate how you think the design of T126 contributes to your learning (N=195)		
Contributes highly	27	14%
Contributes	57	29%
Somewhat contributes	44	23%
Neutral	36	18%
Doesn't really contribute	18	9%
Does not contribute at all	13	7%

When we asked students to indicate what types of classroom activities were most appropriate for the flexible classroom design (on a scale of 1–7 with 7 being the highest score), they gave the highest ratings to:

- whole class discussion
- peer review
- interacting with classmates
- interacting with instructor
- watching videos (perhaps because of the setup of the perimeter LCD screens, which several students indicated improved visibility)

Students gave the lowest scores to the following two activities:

- doing research
- writing independently

Many of the highest-ranked activities are collaborative in nature. While these results are preliminary and only indicate a potential trend, they indicate a flexible BYOT classroom might facilitate the kinds of activities that we most value in writing classrooms: those that are collaborative in nature. Such responses, however, might also correlate with the ways students saw teachers using the mobility of the classroom in a particular section of first-year writing.

One of the considerable expenses in setting up BYOT classrooms was the rewiring of the classrooms to give students individual access to power outlets (approximately $4,500). In a fixed classroom design, the outlets were provided around the perimeter of the classroom, next to individual tables where clusters of students were seated. In the flexible classroom design, we decided to still put outlets around the perimeter of the room and then see how frequently students accessed power. While it would be possible to rewire the room to provide power at various places in the floor or throughout the room, we were not certain if student use of power outlets would justify the expense. Of the 195 students who responded to our survey, 30% reported never plugging in a laptop in class, while 15% reported plugging in their laptops daily. The other 55% of students gave responses to varying degrees (plugging in weekly or perhaps monthly). With classes that are 50 minutes long and 100 minutes long, we found that rewiring the classrooms beyond the perimeter outlets was likely not necessary at this time, especially as battery life for mobile technology becomes increasingly long.

7. Conclusions and future directions

In a challenging economy where budgets for academic programs seem to shrink each year, writing programs face serious economic challenges. When such fiscal challenges are paired with the ever-changing nature of writing technologies and the need to update classroom technologies on a regular basis, the challenges can seem insurmountable. Our flexible BYOT classroom project sought to answer the question: how do we take existing classroom spaces and small/shrinking budgets and make the spaces work well for the teaching of writing?

We have found that a flexible BYOT classroom design is a cost-effective solution that provides a win-win for our writing program. It provides the flexibility for classroom activities and pedagogical approaches that teachers longed for when we implemented our fixed BYOT classroom while maintaining economic sustainability for the future. The initial cost for setting up a classroom space is less than the cost of upgrading a computer classroom, and the cost is

incurred less frequently. While the furniture in flexible classrooms would ultimately need to be replaced or updated, such upgrades would not take place as regularly as the need to upgrade technology in computer classrooms, and the pedagogical benefits of a flexible design seem to work better for writing classes that emphasize collaboration.

The primary ethical concern that remains with a flexible BYOT design is that students are responsible for providing their own technology. In institutional contexts where students are not required to purchase laptops or other appropriate mobile devices (and therefore do not have financial support for such technology), a BYOT design creates an environment of exclusion for students who cannot afford to purchase their own technology. If an institution does not have a laptop policy, it is essential to maintain checkout laptops for students and consider the cost of initial purchase and maintenance in the overall costs of moving to a BYOT design (flexible or not). Additionally, a checkout policy should be in place that provides those students with similar flexibility and out-of-classroom access to technology that other students would have. Ultimately, writing programs, and institutions of higher education as a whole, need to consider the needs of their student population. What benefits are there to having students purchase instructional technology, and what support can the institution provide so that students are not disadvantaged by increased financial strain?

Ultimately, we have begun to make peace with the rising costs of teaching writing with technology by looking for sustainable solutions that address both pedagogical and economic needs. By continuing to collect responses from teachers and students that indicate their desires and needs, we can rely on their voices to help us refine our strategy for the future.

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