Connectedness by Design: The Teaching Laboratories in St. Olaf College's Regents Hall of Natural and Mathematical Sciences

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This study assessed the impact of science teaching laboratories designed with visual connections to spaces outside the laboratory, either to interior spaces or to the outdoors. Specifically, we assessed (1) student perceptions of interdisciplinarity, (2) the ability to stay focused, and (3) the environment for student learning. Student surveys were administered in 2008 in St. Olaf College's old Science Center (windowless teaching laboratories) and in 2009 in St. Olaf College's new Regents Hall of Natural and Mathematical Sciences (same time of year, same courses). Our results indicate that students in Regents Hall have a better appreciation of what happens in science labs in disciplines outside of their major, are more satisfied with the number of windows, have a greater sense of connection with the outside world, like coming to the laboratory more, are better able to stay focused, and are less anxious to leave the laboratory at the end of the lab session. However, we found no difference in the extent to which activities outside the laboratory interfered with student's ability to focus on their work. We therefore recommend visual connectedness within teaching laboratories as a useful strategy for those considering new or renovated science facilities.

In the design of science teaching laboratories, there are many reasons to seek connectedness to the environment outside of the laboratory, a connectedness that includes both sight lines to spaces within the building as well as views of the outdoors. For one, in light of the push in the sciences toward greater interdisciplinarity (National Research Council, 2003), better visibility of the science happening across the disciplines might enhance student appreciation for the practice of science in disciplines outside of their major(s). Furthermore, there has been a sense among designers and users that making science more visible to building occupants/visitors yields a greater public understanding of science. One could also assert that seeing fellow students/faculty/staff through windows in the walls of the teaching laboratories builds camaraderie and collegiality. For laboratories located on external walls, taking full advantage of natural light and views to the outside is consistent with a multitude of studies that have documented the relationship between learning/well-being and connectedness to the environment (Goldstein, 2006). Finally, safety is a factor, as a visible laboratory will stand a greater likelihood of generating responders in the case of a laboratory accident.

Despite the potential advantages to teaching labs with abundant internal and external windows, there are legitimate reasons for concern with this design strategy. Especially with internal windows to hallways and public gathering spaces, there is a concern for the fishbowl/zoo effect, whereby performance or comfort is inhibited because laboratory users constantly feel under observation and scrutiny. Students and faculty may also be distracted from their work more frequently in highly visible labs in a manner that works counter to the task at hand.

In spite of the attention and investment paid to building spaces to promote science learning (Project Kaleidoscope, 1998; Narum, 2004), very little systematic study of the design of science teaching laboratories has been carried out. This is somewhat surprising because, like the users of the Swenson Science Building at the University of Minnesota–Duluth (opened 2005), many educators and design professionals have a sense that "physical environment can be as important as curriculum in achieving educational goals" (Wesel, 2008).

At St. Olaf College (liberal arts college of ~3,000 undergraduates; www.stolaf.edu), we found ourselves in a position to address the benefits/drawbacks to a highly connected teaching laboratory design. In the spring of 2008, we were in the final semester occupying a science building consisting almost entirely of internal teaching laboratories without views either to the outdoors or to

hallways and public spaces (our old Science Center, built in 1968, had offices located on the outside [with windows] and labs found in internal spaces with no natural lighting).

By spring 2009, we were teaching essentially the same laboratory curriculum in spaces that were either located on exterior walls with abundant windows to the outside or in interior spaces intentionally placed adjacent to a central atrium with a ribbon of windows to allow views into and out of these teaching laboratories.

This study describes the results of surveys administered to students enrolled in several different laboratory courses, either in the spring of 2008 when students still resided in our old Science Center or in the spring of 2009 after we had moved into St. Olaf's new Regents Hall of Natural and Mathematical Sciences. The purpose of this study was threefold. First, we sought to assess the impact of laboratories with high visible connectedness on student perceptions of interdisciplinarity. Second, we sought to determine if students find windows and a highly connected environment to be distracting to their work or distasteful because of the fishbowl/zoo effect. Finally, we sought to compare the environment for student learning in the new versus old building. Our hope is that sharing the results of these surveys will prove helpful to those considering where to locate teaching laboratories within new or renovated science buildings and whether to place windows in between the teaching laboratory and internal public spaces.

St. Olaf College's Regents Hall of Natural and Mathematical Sciences

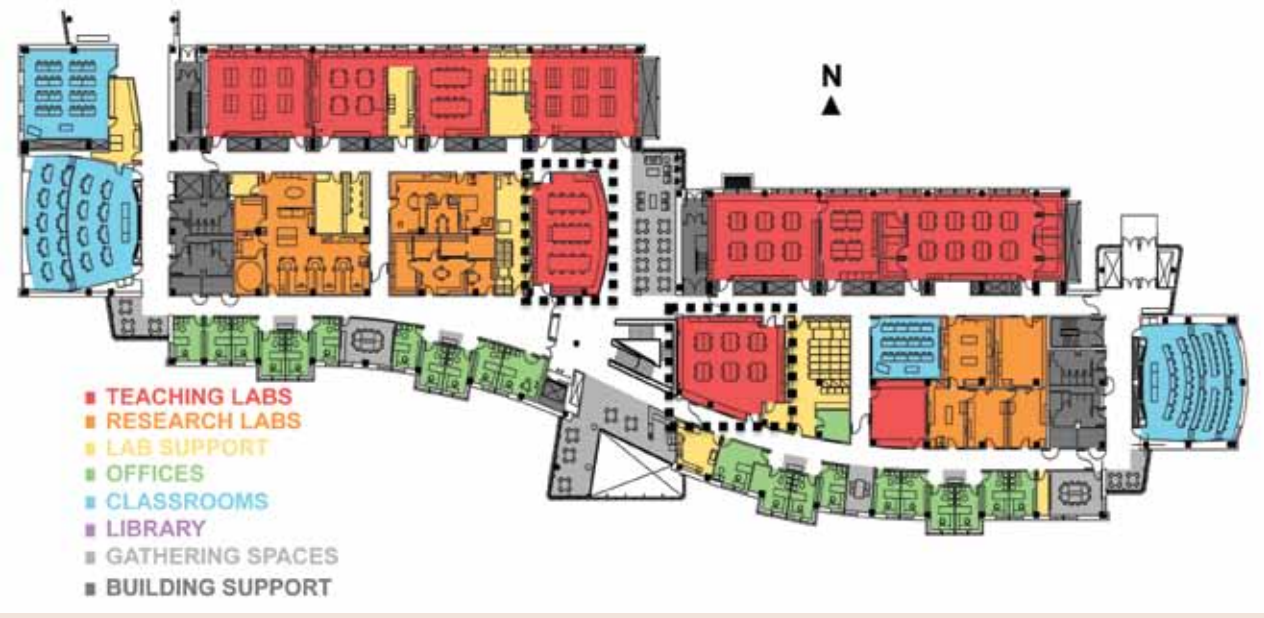
Regents Hall of Natural and Mathematical Sciences (www.stolaf.edu/regentshall) consists of a 195,000 gross square foot new building for the natural sciences (biology, chemistry, physics, and psychology), 18,000 gross square feet of renovated space for the mathematical sciences (mathematics, statistics, and computer science), and an 8,000 gross square foot link between these two buildings. The natural sciences and link portions of Regents Hall opened in fall 2008; the renovated mathematical sciences building opened in fall 2009.

The design of Regents Hall was an integrated, collaborative, and vision-driven design-build process that involved faculty, students, facilities personnel, campuswide representatives, architects (Holabird & Root, LLC), and construction managers (Oscar J. Boldt Construction Company). Driven by a programmatic vision that we packaged into our "Seven Is," we continuously asked whether Regents Hall would do the following:

- promote *interdisciplinary* work;
- encourage an *investigative* approach to the natural and mathematical sciences;
- support the *interactive* nature of modern science;
- accommodate the *innovations* that bring technology into the classroom and laboratory;
- be *inviting* to students, faculty, staff, and visitors;
- incorporate *interconnections* between the sciences and other dis-

FIGURE 1

Floor plan for second floor of Regents Hall of Natural and Mathematical Sciences. Spaces are color coded by function. Dashed lines highlight the two "showcase" teaching labs on this floor.



tinctively St. Olaf strengths; and
- embody the *integrity* characteristic of St. Olaf College.

At a glance, Regents Hall has the following:

- 26 teaching labs, 7 tiered classrooms, 11 flat-floored classrooms, 8 seminar rooms, and 4 computational rooms;
- 13,000 square feet of student–faculty research space, much of it shared to foster collaboration, enhance access to common equipment, and minimize duplication of laboratory services; and
- certification as an environmentally sustainable Platinum LEED building shaped by a commitment to green chemistry and highlighted by natural light penetration deep into the interior spaces, plentiful views to the outdoors, and an accessible green roof terrace.

The general layout of the natural sciences portion of Regents Hall is shown in Figure 1. Offices are located on the south side, teaching labs are on the north side, and research labs and support spaces are housed centrally. Flat-floored classrooms are dispersed throughout while the larger tiered-classrooms are located at the east and west ends.

Regents Hall is organized in a fashion that fosters interdisciplinarity while sustaining disciplinary foundations. There are deliberately designed interdisciplinary areas throughout the building, including clusters dedicated to neuroscience, biomolecular science, and the environmental sciences, but one can also find disciplinary

FIGURE 2

Left panel—view of showcase teaching lab from atrium. Right panel—view from interior of showcase lab.

PHOTOS COURTESY OF MADISON VAN WYLEN.

FIGURE 3

Left panel—north teaching lab with views to the outdoors. Right panel—view from hallway into north lab.

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"homes" in the building. Faculty office and research laboratories are organized by common interests regardless of their disciplinary home, an arrangement that makes interactions among faculty from different departments much more likely than in our old building where each department occupied its own floor and the five departments were scattered among three different buildings. A detailed description of the advantages of this arrangement on our Neuroscience program is available elsewhere (Muir & Van Wylen, 2009).

A central crossroads atrium allowed us to place five "showcase" teaching labs in a flanking position to the central atrium (see dashed lines in Figure 1). As shown in Figure 2 (left panel), these labs have a ribbon of windows facing the atrium, giving them a broad view of activity occurring in the atrium from within (right panel). In addition, all teaching labs on the north hallway have large windows to the outside (Figure 3), as well as full-length windows in the doors to the hallways.

Methodology

Survey and data collection

Students enrolled in biology, chemistry, physics, and psychology lab courses were asked to complete a short survey about their experiences in the spring of 2008 and 2009. The survey statements are listed in Table 1. Students responded on a 5-point Likert scale with *strongly agree,*

TABLE 1

Student responses to statements in 2008 and 2009.

	Statement	2009 Score[1]	2008 Score[1]	Counts	2009	2008	Percentages	2009	2008	X^2 (p-value)	Odds Ratio (2009/2008)
1	**The way departments are organized in this building helps me appreciate what happens in science labs in disciplines outside of my major.**	2.4	3.0	A	168	85	A	60	36	30.4 ($p<0.001$)[2]	**2.7**
				Not A	112	153	Not A	40	64		
2	**The way laboratories are designed in this building helps me appreciate what happens in science labs in disciplines outside of my major.**	2.4	2.9	A	179	73	A	64	31	56.4 ($p<0.001$)[2]	**4.1**
				Not A	101	164	Not A	36	69		
3	**I feel connected to the outside world during lab sessions for this class.**	2.3	3.5	A	183	56	A	66	24	90.9 ($p<0.001$)[2]	**6.0**
				Not A	95	180	Not A	34	76		
4	**External activities during my lab sessions interfere with my ability to focus on my laboratory work.**	3.9	3.7	A	26	26	A	9	11	0.4 ($p=0.54$)	**0.84**
				Not A	251	210	Not A	91	89		
5	**I am satisfied with the number of windows to the hallway in this laboratory.**	1.9	3.6	A	222	43	A	80	18	192 ($p<0.001$)[2]	**17.6**
				Not A	56	191	Not A	20	82		
6	**I enjoy the physical ambiance of this laboratory.**	1.9	3.2	A	238	58	A	85	25	193 ($p<0.001$)[2]	**17.8**
				Not A	41	178	Not A	15	75		
7	**The physical aspects of this lab (as opposed to the curricular aspects) help me stay focused during lab sessions.**	2.2	2.7	A	196	99	A	70	42	40 ($p<0.001$)[2]	**3.3**
				Not A	84	135	Not A	30	58		
8	**As a laboratory space, I think this lab is well-designed.**	1.8	2.8	A	254	95	A	91	41	149 ($p<0.001$)[2]	**14.9**
				Not A	25	139	Not A	9	59		
9	**Regardless of the specific lab session, I like coming to this laboratory for lab.**	2.0	3.0	A	215	83	A	77	35	92 ($p<0.001$)[2]	**6.0**
				Not A	65	154	Not A	23	65		
10	**By the end of my lab sessions, I am tired of being in this space and anxious to leave.**	3.1	2.2	A	76	165	A	27	70	93 ($p<0.001$)[2]	**0.16**
				Not A	203	72	Not A	73	30		
11	**I take breaks and leave the laboratory during lab sessions to relax and clear my mind.**	3.3	3.3	A	82	71	A	29	30	0.013 ($p<0.91$)	**0.98**
				Not A	196	166	Not A	71	70		

[1]The Score is calculated by multiplying the number of "strongly agree" responses by 1, "agree" by 2 etc. Lower scores indicate higher levels of agreement with the statement.

[2]Statistically significant at the 95% confidence level.

agree, neutral, disagree, and *strongly disagree* responses. In 2008, the courses in question were taught in the old Science Center and Holland Hall (the former home of the Psychology Department). In 2009, all courses were taught in the new Regents Hall of Natural and Mathematical Sciences.

Student responses were gathered anonymously using an in-house online survey tool. Course sections were selected to participate in order to provide responses from different disciplines, course levels, and intended majors. Only two lab sections of larger, introductory courses were chosen to participate.

The survey was conducted at the same time each year: 4/28/08–5/14/08 and 4/27/09–5/13/09, during the last two weeks of classes. There were no major changes in lab content between the two years, nor was there a significant infusion of additional equipment in the new building. Data were collected from a total of 239 and 281 respondents in 2008 and 2009, respectively. This corresponds to response rates of 70% and 71%. The number of responses, response rate, type of lab room, and group of students enrolled in each course are shown in Table 2. The project included both science and nonscience majors and primarily focused on introductory-level courses. Students were also given an opportunity to write open-ended comments about the lab spaces.

Analysis methods

The data were analyzed using chi-squared tests and logistic regression. The student responses were grouped into two categories: "agree," including both *strongly agree* and *agree* responses and "not agree," including all other responses. The counts and percentages of the *agree* and *not agree* responses for each question in 2008 and 2009 are shown in Table 1. From the counts, a chi-squared statistic was calculated (Table 1).

TABLE 2

Information on lab courses surveyed in 2008 (old building) and 2009 (new building).

		2008			2009		
Course (Majors of Students)	**Title**	**Number of respondents**	**Percentage of response**	**Lab type**	**Number of respondents**	**Percentage of response**	**Lab type**
Bio 126 (Biology)	Evolution and Diversity	34	71	Interior	36	86	Showcase
Bio 233 (Biology/ Premed)	Intermediate Genetics	35	67	Interior	41	77	North
Bio 261 (Biology/ES)	Ecological Principles	36	77	Exterior	37	74	North
Chem 111 (Nursing/ Gen. Ed.)	Chemistry and the World	21	81	Interior	35	78	Showcase
Chem 126 (Chemistry/ Biology)	Energies and Rates of Chemical Reactions	36	75	Interior	45	74	North
Phys 125 (Chemistry/ Biology)	Principles of Physics II	28	62	Interior	21	47	North
Physics 127/31 (Physics)	Analytical Physics II	25	71	Interior	34	87	Showcase
Psych 126 (Psychology)	Investigative Explorations in Psychology	24	60	Interior	32	53	North
Overall		239	70	---	281	71	---

Logistic regression analysis in which the year (2008 or 2009) was the only variable was also performed. From the coefficients of this model an odds ratio of an agree response in 2009 compared with 2008 was also computed (Table 1). For a few statements, the department and/or type of lab also led to statistically significant terms in the regression model. In most cases, we could ascribe the differences to a particular discipline or lab room involved. For instance, students in biology labs were more likely to agree with Statement 3 ("I feel connected to the outside world during lab sessions for this class"); two of the spring-semester biology courses surveyed involved field exercises. Psychology students were less likely to agree with Statement 5 ("I am satisfied with the number of windows to the hallway in this laboratory"); the shades on the hallway windows are often pulled for psychology labs. Students enrolled in courses that met in "showcase" labs were more likely to agree with Statement 5 ("I am satisfied with the number of windows to the hallway in this laboratory"); these laboratories had many more windows to the interior building space than other labs. In the old Science Center, 47% of the students in Ecological Principles (Bio 261) agreed with Statement 3 ("I feel connected to the outside world during lab sessions for this class") versus 20% agreement from students in the other labs; the Bio 261 lab was the only lab in the old building that had windows to the outside. Because of these nuances in the data, we chose to report results of the simple logistic regression model in which *Year* is the only variable.

Results

The comparison of student responses in 2008 and 2009 is shown in Table 1. In addition to the actual counts, the table shows the average Likert scores, the percentage of students who agree with each statement, the chi-squared statistic and corresponding *p*-value, and the calculated odds ratio of students agreeing with the statement in 2009 compared with 2008. For example, 60% of the students agreed with Statement 1 in 2009 compared with 36% in 2008; the odds ratio calculation for these data indicate that students were 2.7 times more likely to agree with Statement 1 in 2009 in comparison with 2008. The odds ratio also indicates the magnitude of difference in the response to the statement between the two years; the differences were greater for Statements 5 and 6 (odds ratio ~18) than for the other questions.

All statements showed a statistically significant difference in student responses in 2008 and 2009 except Statements 4 and 11 (indicated in green in Table 1). For the statements with statistically significant differences, students were more likely to agree in 2009 than in 2008 for all questions except Statement 10 ("By the end of my lab sessions, I am tired of being in this space and anxious to leave"). The odds ratio of students responding favorably to Statement 10 was larger in 2008 than 2009. Examining the wording of the statement shows that students responded more positively to the spaces in 2009 than 2008; students were six times more likely to disagree with the notion of being tired by the end of the lab session in 2009 than in 2008.

A summary of the relevant open-ended comments is shown in Table 3. For brevity, we have excluded the many brief comments (e.g., "Dark and dreary" or "I love the windows" or "Thank you so much! This lab space is wonderful!"). While the comments are in general consistent with the statement responses, it is important to point out that a few of the 2009 students specifically mention the fishbowl effect.

Discussion

There were three goals for this study. First, we wanted to assess the impact of laboratories with high visible connectedness on student perceptions of interdisciplinarity. On the basis of the responses to Statements 1 and 2, students in the new building have a better appreciation of what happens in science labs in disciplines outside of their major. This apparently is a result of both the mixing of departments throughout the building (Statement 1) and by the way the laboratories are designed (Statement 2). Although we did not ask specifically about the role of windows in this increased sense of interdisciplinarity, these data suggest that the visibility of other disciplines is more apparent in the new building than it was in the old building.

The second goal of this study was to determine if students find windows and a highly connected environment to be distracting to their work or distasteful because of the fishbowl/zoo effect. On the basis of responses to Statements 3 and 5, students had a greater sense of connection with the outside world (Statement 3) and were more satisfied with the number of windows in the laboratories (Statement 5) in the new building than in the old building. There was, however, no difference in the extent to which activities outside the laboratory interfered with students' ability to focus on their work (Statement 4). Given the marked difference in the number of windows in the new building compared with the old, this is highly indicative that the fishbowl or zoo effect is not an issue for our students in our new laboratories. We did have an occasional negative comment about the number of windows in the lab, so there is a legitimate concern about laboratories with abundant windows. However, on balance, the students overwhelmingly like the connectedness of the teaching laboratories in the new building and do not feel more distracted by external activities.

Finally, we sought to compare the environment for student learning. Statements 6, 7, 8, 9, 10, and 11 address this issue. Thankfully, given the

TABLE 3

Open-ended student comments.

2008 Open-ended comments	2009 Open-ended comments
Biology 126	**Biology 126**
It does not make me want to show up to lab, ever. The lighting feels like it is sucking life out of me.	I feel like I am in a fish bowl. I do not really care about the laboratory space; if I liked the labs anything would be fine.
	The windows in the biology labs are aesthetically appealing, but it is very easy to become distracted when people pass the lab.
	I love the number of windows, and it is very bright. I much prefer coming to lab in Regents than in the Old Science Center.
Biology 233	**Biology 233**
Windows would help me be more connected, and feel less anxious about being in lab.	The windows are great—a huge improvement over the old science center labs. The natural light greatly helps to maintain focus for longer periods of time.
I hate the fact that there are no windows in the lab. I feel like I am in prison when I'm in lab.	The windows are beautiful and help keep energy high during a long lab, but there are also times when we need to filter out the outside world.
The line between having ambiance, windows, and inviting spaces while still maintaining a laboratory atmosphere in which distractions are at a minimum is a difficult line to establish. However, I think having more natural light would help ease the starkness of a closed in, artificial space.	Honestly, labs should have less to do with the laboratory space as whole and more to do with the professors.
Not just in this lab, but all the science labs, it would be great to have windows allowing natural light to come in. When labs are 3–4 hrs long, it is hard to stay focused and engaged when we are working in these boring, structured rooms. I do not like going to lab because of the ambiance, and I hope there will be great changes in the new science center.	I love the new science center; the natural lighting definitely doesn't make you feel closed off.
Biology 261	**Biology 261**
Having a window makes this lab SO much better than all of the other labs I have been in! I actually WANT to come to this lab (even if the lab itself is not always engaging). Please put MORE WINDOWS in MORE PLACES in the rooms in the new building! They make all the difference in the world!	The windows make a huge positive difference. They're well designed!
The space doesn't really matter. It is the academic work itself that makes the most impact by far.	I love the labs! The windows are so nice compared to the dark, gloomy labs in the old science center. I used to hate going to chemistry labs in the old building.
	The lab is spacious and bright b/c of all of the windows. It is great and a complete 180 from the old science center.
	I LOVE all the windows to the outside world, SUN IS GOOD! I also feel much more connected to the rest of campus during lab (compared to the old science center labs).
	It's a thousand times better than the old science center! The old labs were dungeon like and had no windows. I love being in lab now and being able to see trees and the outside world, and sunlight! Good job!

2008 Open-ended comments	2009 Open-ended comments
Chemistry 111	**Chemistry 111**
When I'm in lab I am there to work. The physical ambiance is not top on my priority list.	I like the windows in our lab. Being in the "fishbowl" is fine for me because it's nice to not be trapped in a lab room. If there were no windows I would not like lab.
	I like it. I don't mind the windows because they let in a lot of light. Sometimes people walking around in front of the windows are distracting but rarely and I like knowing what is going on and seeing my friends walk by.
Chemistry 126	**Chemistry 126**
The lack of windows does not bother me because the labs are well lighted.	Though I sometimes am tired and anxious to leave as a result of the occasional long (or more grueling) lab, the laboratory space itself is never a cause for restlessness.
I'm overall indifferent to the laboratories. They do the job; I can't complain.	The large amount of natural sunlight in the labs is a definite plus for me.
	The light, open atmosphere of the laboratory really helps make 3-hour sessions less grueling!
Physics 125	**Physics 125**
Windows to the outside would be nice. Not to the hallway.	I really like the windows and the use of natural light in the lab, it definitely helps lab to seem less intense and makes time pass quicker.
To be quite honest, the physics labs depress me. It is so dreary being in the basement of the Science Center, with no windows, in such an ugly room. I think I would even enjoy the experiments better if the space were more pleasant to be in.	Enough windows and natural light to keep me sane while I work.
I don't enjoy coming to physics lab. The lab room is depressing and old, and there are no windows!	
Physics 127	**Physics 131***
It is too dungeon like. Seeing daylight would help improve my overall attitude. I do like how the majority of the physics labs are connected because I don't have to move around too much when I'm trying to work.	The labs don't seem that special, I mean, my physics lab space is just an open room with some computers. The windows are nice because they make the space feel more open, but when all is said and done, a lab is a lab.
	I enjoy being able to see what's going on in the bio lab.
Psychology 126	**Psychology 126**
The Psych 126 laboratory is in a very awkward, cold, windowless, isolated area that does not encourage students to pursue psychological research nor does it encourage linking psychology with other scientific disciplines.	I really like the large set of windows facing Holland Hall. The great amount of natural light is very helpful for keeping morale high during a three-hour lab.
	I LOVE the wall of windows. Helps me focus and be happy.
	I think it's perfect. The brightness and less-constrictive space help me enjoy coming to lab much more than the old science building! I don't dread labs like I did before—I used to consider it equivalent to going to the dungeon. Now, I feel like I am conducting respectable investigations that are worthwhile in a modern context.

* Physics 127 was revised in 2009 and given a new course number (Physics 131).

time and money invested in Regents Hall, students enjoy the ambiance of the laboratories (Statement 6) in the new building and find much greater agreement that the labs are well designed (Statement 8). More important as it relates to the environment for student learning, however, students in the new building now like coming to the laboratory regardless of the lab session (Statement 9), are better able to stay focused (Statement 7), and are notably less anxious to leave the laboratory at the end of the lab session. Given that our teaching labs are typically 3–4 hours long, it is impressive that in Regents Hall only 27% of the student respondents agreed that they were "tired of being in this space and anxious to leave" by the end of the lab session, compared with 70% in the old building. There was no difference in the student responses to Statement 11, indicating that taking breaks during lab periods is not a part of our campus culture.

Although the present study focused on teaching laboratories, our data are consistent with the more commonly studied issue of classroom design and student learning (Oblinger, 2005; Strange & Banning, 2001). Most classroom studies have focused on structural components such as table/chair design/arrangement; sight lines; the distance between students and the instructor; and the impact of noise, lighting, color, and temperatures (Herzog, 2007; Potthoff, 2009; Veltri, Banning, & Davies, 2006; Waters, 2007). However, as it related to windows in classrooms, Herzog (2007) found that first-year students who took more than half of their classes in rooms with windows were more likely to be retained for the sophomore year than those taking fewer than a third of their classes in rooms with windows. Students who took more than half of their classes in rooms with windows were also more likely to have higher GPAs than those taking fewer than a third of their classes in rooms with windows. However, after controlling for math or English experience, it was not clear whether the number of classes taken in windowless rooms or in rooms with natural lighting influenced the first-year GPA of students in a positive or negative direction.

Beyond assessment of windows in the teaching labs, Regents Hall offers other opportunities to lend insight into how facility design can augment student learning. We incorporated three different layouts into our larger (60–72 seat) tiered classrooms, each of which in its own way fosters classroom interaction. Nearly all research laboratories are larger shared spaces designed to foster collaboration and interdisciplinary research. We could also evaluate the impact of informal gathering spaces and a local café on building use and student learning.

Conclusions

A tremendous amount of time and energy is being expended on building science facilities for the 21st century. Without data and in the face of some legitimate concerns, many users and designers seek greater connectedness in part by incorporating windows in teaching labs both to the outside and to interior spaces. In our context, students find this overall approach to be a useful addition for making the activities in other disciplines more visible but do not find the windows distracting to their own lab work. Given that the overall environment for student learning is enhanced in our highly connected teaching laboratory design, we recommend this as a useful strategy for those considering new or renovated science facilities. ■

References

Goldstein, R. N. (2006). Architectural design and the collaborative research environment. *Cell 127*, 243–246.

Herzog, S. (2007). The ecology of learning: The impact of classroom features and utilization on student academic success. *New Directions for Institutional Research, 135*, 81–105.

Muir, G. M., & Van Wylen, D. G. L. (2009). Facilities planning for the neuroscience curriculum at a primary undergraduate institution: St. Olaf College's Regents Hall of Natural and Mathematical Sciences. *Journal of Undergraduate Neuroscience Education, 8*, A73–77.

Narum, J. L. (2004). Science spaces for the students of the 21st century. *Change, 36*(5), 8–21.

National Research Council. (2003). *BIO 2010: Transforming undergraduate education for future research biologists*. Washington, DC: The National Academies Press.

Oblinger, D. (2005). Leading the transition from classrooms to learning spaces. *EDUCAUSE Quarterly, 28*, 14–18.

Project Kaleidoscope. (1998). *What difference do improved facilities make?* Retrieved from http://www.pkal.org/keywords/Facilities.cfm

Potthoff, J. (2009). Design for communication: Post-occupancy evaluation of classroom spaces. *Open House International, 34*, 26–34.

Strange, C. C., & Banning, J. H. (2001). *Education by design*. San Francisco, CA: Jossey-Bass.

Veltri, S., Banning, J. H., & Davies, T. G. (2006). The community college classroom environment: Student perceptions. *College Student Journal, 40*, 517–527.

Waters, J. K. (2007). A movable feast. *T.H.E Journal, 34*(12), 40–44.

Wesel, L. (2008). *University of Minnesota's Swenson Science Building improves education: Better design engages students in hands-on learning*. Retrieved from http://www.tradelineinc.com/content/29049/display/a3%3Bcng

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