Article

Classrooms With Nature Views: Evidence of Differing Student Perceptions and Behaviors

Environment and Behavior
2015, Vol. 47(2) 140–157

DOI: 10.1177/0013916513499583
eab.sagepub.com
SAGE

Jacob A. Benfield[1], Gretchen Nurse Rainbolt[2], Paul A. Bell[3], and Geoffrey H. Donovan[4]

Abstract

Viewing peaceful natural environments has been shown to restore cognitive abilities and reduce physiological arousal. As such, visual access to the natural environment is becoming more commonplace in built environments. One exception to that trend is in educational settings where windowless classrooms are used to reduce outside distractions. The current study examines differences across multiple sections of a college writing course in two types of identically designed classrooms—those with a view of a natural setting and those with a view of a concrete retaining wall. Results showed that students in the natural view classrooms were generally more positive when rating the course. Students in the natural view condition also had higher end of semester grades, but no differences in attendance were observed between conditions. Such findings suggest that classrooms with natural views offer advantages and also suggest that the inclusion of natural elements in courses could facilitate positive perceptions and better grades.

[1]Pennsylvania State University–Abington, USA
[2]Sacramento, CA, USA
[3]Colorado State University, Fort Collins, USA
[4]U.S. Forest Service, Portland, OR, USA

Corresponding Author:
Jacob A. Benfield, Division of Social Sciences, Pennsylvania State University–Abington, 1600 Woodland Rd, Abington, PA 19001, USA.
Email: jab908@psu.edu

Keywords
education, biophilia, restoration, nature, design

The biophilia hypothesis posits that humans have an innate affinity toward life and life-supporting environments (Wilson, 1984). For example, it has been shown that humans have a preference for savannah-type trees (e.g., Falk & Balling, 2010) and nonturbulent water (e.g., Han, 2007), both of which are known to have afforded survival throughout human history. Along similar lines, biophilia research shows that individuals have greater preference toward, and lower stress in the presence of, landscape-style versus abstract paintings or art (e.g., Eisen, Ulrich, Shepley, Varni, & Sherman, 2008). Interactions with other organisms such as fish, domestic canines, and birds have also been shown to improve the human condition (e.g., Windhager, Atzwanger, Bookstein, & Schaefer, 2011). Because of these findings, researchers continue to show interest in the effects of biophilic, natural environments in everyday life, often in the context of window views and visual access.

Visual Access to Natural Environments

Having visual access to nature is known to be beneficial across a wide range of contexts. For example, research in the area of healthcare and physical well-being has shown that the view out the window can influence health outcomes (see Devlin & Arneill, 2003 for a review). Seminal work by Ulrich (1984) showed that patients recovering from gall bladder surgery who had views of trees recovered from surgery significantly faster, had fewer negative interactions with nursing staff, and used fewer analgesic medications when compared with those recovering in rooms with a less scenic brick wall window view. Follow-up research showed similar effects with individuals recovering from cardiac surgery but used an experimental method involving static scenes presented immediately before the procedure (Ulrich & Lunden, 1990). The presence of natural light, which is facilitated by the presence of windows, has also been shown to aid in recovery following spinal surgery (Walch et al., 2005). Along related lines, Baird and Bell (1995) report an interesting case in which an isolated leukemia patient became more attached to a room that overlooked the cemetery she would eventually be buried in, because it contained a stand of trees that was more natural than the alternatively available view. Moore (1981) reported data indicating that prisoners who resided

in cells overlooking an open field required fewer visits to the infirmary when compared with prisoners residing in cells without the natural view, and Heerwagen (1990) found that visual access to natural murals reduced anxiety and blood pressure in dental patients.

The benefits of window views and natural features within the workplace have also been examined with similar results (see Farley & Veitch, 2001 for a review). For example, Kaplan (1993) reported two separate studies on the presence versus absence of natural window views. In the first case, workers with natural views reported fewer common health ailments in the preceding 6-month period and higher job satisfaction. In the second study, natural views were related to increased feelings of privacy and satisfaction; natural views were also associated with lower frustration and increased patience and task enthusiasm. In a similar line of research, having a view of forested settings was related to greater job satisfaction and lower stress in a South Korean sample (Shin, 2007). Artificial window views in the form of plasma televisions do not provide the same restorative effects (Kahn et al., 2008), and workers without window views are more likely to bring in plants and natural pictures to compensate for the lack of access to the outside environment (Bringslimark, Hartig, & Patil, 2011).

Beyond hospitals and offices, the benefits of having visual access to the natural environment have been demonstrated in residential spaces. Kaplan (2001) showed that the type of view out a residential window can have similar effects. By surveying residents in six low-rise apartment buildings, it was shown that nature views promoted residential satisfaction and overall resident well-being (Kaplan, 2001). Similarly, Tennessen and Cimprich (1995) examined college residence halls and the role that window view played on the restoration of directed attention by testing students living in three separate residence halls and then grouping them based on the type of scenery visible from the room window. They found that residents with all natural, or mostly natural, views from the residence hall window had performed better on two separate objective measures of directed attention and also rated themselves subjectively as having greater ability to focus attention. Likewise, Taylor, Kuo, and Sullivan (2002) showed that inner city girls who had visual access to natural spaces from their residence exhibited higher levels of self-discipline in the form of greater concentration, impulse inhibition, and ability to delay gratification.

Windowless Environments

Unfortunately, not all built environments facilitate visual access to nature or natural elements. Despite the wealth of empirical evidence showing that

natural window views can have a wide range of positive impacts on those who use the space, some situations have led designers to purposively exclude windows and other forms of visual access. This is often done on purpose to limit the amount or type of information provided to the occupants or to facilitate the behavioral goals of the setting.

For example, casinos are often designed to ensnare the occupant by limiting informational cues related to the passage of time (e.g., clocks) or way-finding (e.g., exit signage). Stemming from a combination of legal mandates regarding public displays of gambling and desires to limit access to environmental cues of time or weather (e.g., a sunrise, an approaching storm), windowless casinos are the norm with nearly no exceptions (Sykes, Gaffney, Sykes, & Posner, 2010). Others have pointed out how the lack of windows in museums (often done intentionally to aid in artifact preservation) likely relates to some of the way-finding and fatigue problems experienced by museum patrons (Bitgood, 2003).

Similarly, classrooms and other educational settings have often opted for a windowless design. Originally proposed as a means for reducing outside noise, distraction, and heating/cooling costs, while increasing space for bulletin boards and bookcases, the windowless classroom is a common design feature in schools (Edwards & Torcellini, 2002). While there is some evidence showing benefits to environmental quality and heating or cooling costs (Langdon & Loudon, 1970), others found decreased academic performance and hormone level differences associated with windowless classrooms (e.g., Küller & Lindsten, 1992). In separate correlational studies focused on the effects of natural light and window views across dozens of schools and wide age ranges, students in classrooms with larger window areas scored higher in mathematics and reading when compared with those in classrooms with smaller windows and less access to light (Heschong Mahone Group, 1999, 2003). Those effects were shown even after controlling for other factors such as grade level, size of school, and student absences. Correspondingly, Tanner (2009) found that by rating the aspects of classroom circulation, day lighting, and window view separately along a 10-point scale and then assigning a total score to the school using a composite of those ratings, significant variability in standardized test scores could be accounted for by these environmental ratings. Related to window views, more positive scores on vocabulary, language arts, and mathematics were predicted by higher ratings of the types of view present.

Furthermore, research shows that natural views are subjectively important to students and teachers. For instance, Karmel (1965) showed that high school students in windowless classrooms when asked to draw a picture of the school were more likely to draw windows when compared with those in classrooms with windows. Likewise, Gulwadi (2006) found that elementary

school teachers seek out natural, restorative settings during breaks and downtime as a way of coping with stress and daily events. In a quasi-experimental approach to the issue, Han (2009) showed that the addition of plants to the back of a Taiwanese junior high school classroom improved student ratings of comfort, friendliness, and room preference from baseline levels within the class. Ratings in the plant condition also exceeded those given in a comparable control classroom that lacked vegetation.

The Current Study

Based on the previous theory-driven research showing that visual access to natural environments has restorative effects on humans, and in response to architectural trends that actively prevent visual access to the outdoors in educational settings, the current study examined the effect of visual access to natural environments in a college classroom setting. Similar to Ulrich's (1984) hospital study, we followed outcomes in classrooms that were architecturally identical except for the view through the windows. Prior to this study, such control over the architectural features of the environments being compared has not been used with the exception of Han (2007), who used comparable classrooms but focused on in-room vegetation rather than views from the window.

In addition, previous literature on window views and academic performance has not included the college classroom as a location of study. While Tennessen and Cimprich studied college students in resident halls, and Han (2007), Tanner (2009), or the Heschong Mahone Group (1999, 2003) studied elementary or junior high classrooms, the effects of window views on more adult students in classroom settings have not been explored.

Dependent measures included subjective ratings of a course and objective indicators of student behavior including attendance and grades. It was hypothesized that classrooms with visual access to natural features would have course ratings that were higher than comparable courses in classrooms without visual access to natural features. Likewise, it was hypothesized that the student attendance and overall course grades would be higher in natural view classrooms when compared with nonnatural view classrooms.

Method

Participants

Some 567 undergraduate students (284 men, 283 women) enrolled in one of the 38 participating sections of an introductory-level college composition

course during the spring semester participated by completing questionnaires distributed in the course. Consistent with the level of the course, participants were about 19 years of age ($M = 18.89$, $SD = 1.57$ years), and 81% were 1st-year college students.

The composition course in this investigation used a common course curriculum and grading rubric across all sections. All requisite course materials (i.e., assigned readings) were also standardized across sections. All course instructors ($n = 24$) participated in an extensive week-long training as part of their course appointment to create fidelity in teaching and assessment across sections. Consequently, this course was well suited for a study wishing to make comparisons across a large number of sections. The classrooms were architecturally identical in size, facilities, number of student desks, location in the basement of the same building, and having a row of windows across the upper wall opposite the entrance. Desks in all the classrooms were normally arranged with the students facing the front board and lectern and projector screen with their backs toward the windows, but for some course exercises, they could be in small groups with some having direct views out the windows. Nine of the course sections ($n = 134$) met in classrooms with window views looking directly at a concrete retaining wall, while the remaining course sections ($n = 433$) met in a classroom with views of an open grassy area containing blossoming trees (see Figure 1). All windows faced in the same southern direction.

Course sections were evenly distributed throughout the day and week between the hours of 8:00 a.m. and 5:00 p.m. with sections of both types of classroom view being offered at the same times—that is, more sections of the natural view condition existed overall, but no specific time period included more than two natural view sections and all time periods included at least one concrete wall condition. Thus, the two conditions were evenly distributed across time and day of the week. Course instructors were assigned to sections arbitrarily based on availability and department need rather than preferred course location. Consequently, no single instructor taught more than two of the 38 sections of the course, and those instructors who did teach multiple sections ($n = 12$) were often split between the two conditions ($n = 4$). No one instructor taught more than 6.0% of the participants, suggesting instructor impact on ratings was minimal. While students were able to see the meeting location of classes when they enrolled, course enrollment numbers were not statistically different between the two window-view conditions. Likewise, there were no differences in demographic characteristics between participants in the two sets of course sections and no students attending the course on data-collection days declined to participate. In other words, characteristics between the two window-view conditions were comparable in many ways including

Figure 1. Views from two example classrooms representing (a) the "concrete wall view" and (b) the "natural view."

the desirability of the day/time, course enrollment, the amount of daylight or heat exposure, and the characteristics of the individuals in the course.

Measures

A one-page questionnaire consisting of demographic questions, a rank ordering of reasons for taking the course, and a set of course ratings was used. The primary variables of interest came from the course-rating task, which required participants to "please rate this section of this course on the following dimensions" using a 5-point Likert-type scale ranging from "very low/poor" to "very high/excellent. Specific course dimensions included "course curriculum," "importance of subject matter," "quality of the course materials," "enthusiasm of the instructor," "quality of the building (layout, lighting, etc.)," "classroom resources (desks, computers, etc.)," "classroom features (size, windows, etc.), and the "students in the course."

In addition to the subjective ratings of the course, two objective measures of student behavior were recorded. Midterm and final grades, calculated as a percentage of points earned relative to the number of points possible, were reported by the course instructor. Similarly, midterm and final attendance, calculated as a percentage of the class sessions attended relative to the number of class sessions held, was also reported by the course instructor.

Procedure

Course instructors were recruited via email sent from the primary course coordinator to all eligible sections of the course encouraging participation in a study on "classroom teaching and student learning." This email informed instructors that participation would require that they allow researchers to collect survey data during the first and last class period. Participation would also require that the instructor submit grade and attendance data midway through the semester and at the conclusion of the term. All 24 instructors representing 38 sections of the course agreed to allow access to their students and course-evaluation data.

Students attending each section of the course were then recruited for participation by researchers who visited the course section during the first week of the semester. Participants were asked to participate in a study on "classroom teaching and student learning" and were then asked to complete the student questionnaire during the first week and the final week of the semester (16 weeks later). Instructors were asked to submit grades and attendance at the middle (Week 8) and end of the semester (Week 16). Participants and course instructors remained naïve to the true purposes of the study until the

Table 1. Tests of Beginning of Semester Rating Differences Between Window-View Conditions.

	Natural view *M* (*SD*)	Concrete wall View *M* (*SD*)	*t* statistic	*p* value
Course curriculum	3.70 (0.81)	3.63 (0.80)	−0.86	.392
Importance of subject matter	**3.83 (0.94)**	**3.63 (0.84)**	**−2.15**	**.032**
Quality of course materials	3.78 (0.78)	3.69 (0.83)	−1.06	.290
Enthusiasm of instructor	**4.19 (0.81)**	**4.41 (0.67)**	**2.79**	**.005**
Quality of the building	3.42 (0.92)	3.34 (0.89)	−0.80	.424
Classroom resources	3.32 (0.97)	3.24 (0.90)	−0.80	.423
Classroom features	3.36 (1.02)	3.36 (0.99)	0.03	.974
Students in the course	3.73 (0.85)	3.81 (0.87)	0.85	.395

Note. The bold values indicate which means are significantly different from one another.

end of the term when they were debriefed about the purposes of the project after the final data-collection session.

Results

As a test of initial homogeneity between conditions, independent samples *t* tests were run comparing the two window views on mean scores for all eight student ratings provided at the beginning of the semester. Six of the eight ratings were not significantly different for students with and without views; those with a natural view perceived the course subject matter to be more important and those without the nature view perceived the instructor to be more enthusiastic (see Table 1).

To test the broad hypothesis that classrooms with window views providing visual access to nature would relate to greater benefits compared with classrooms with window views not providing visual access to nature, a series of multilevel models were run. Such hierarchical modeling was used to allow for testing the effect of window view on student ratings and course performance while accounting for the role of section, instructor, and classmates across conditions. In all final models, the eight individual beginning of semester ratings were included as Level-1 predictors, while course instructor, mean semester ratings for each course section, and window-view condition were included as Level-2 predictors. Baseline models testing only the effect of section (Model 1) or the effect of section and all other control variables (Model 2) were used for model comparisons and the calculation of unique variance explained by window view in the full models (see Hayes, 2006;

Snijders & Bosker, 1999). Results were partially supportive of the broad research hypothesis with significant final models displayed in Table 2.

The first outcomes of interest were the eight end of semester ratings for the course, materials, and instructor. After controlling for the eight beginning of semester ratings (Level 1; grand mean centered) and course section, instructor, and section average ratings (all level 2), results of the models showed that window view related to significant differences on some ratings. Specifically, student ratings of the quality of course curriculum ($\gamma_{01} = .30$, $p = .022$), classroom resources ($\gamma_{01} = .32$, $p = .024$), and course materials ($\gamma_{01} = .49$, $p = .000$) were significantly higher in the natural view condition. Recall that curriculum and course materials were the same across all sections of the course and that all classrooms contained identical classroom resources. No differences were shown between classroom views for importance of the subject matter, enthusiasm of the instructor, or ratings of the quality of the building, classroom features, or the other students in the course (all p's $> .10$).

For each of the two objective performance measures, attendance and grades, two separate analyses—midterm and end of semester—were conducted. Regarding midterm and final attendance, results of the multilevel model showed no statistically significant effect of window view after covarying out the level 1 and level 2 predictors. However, an effect of window view was shown on end of term grades in the course ($\gamma_{01} = 1.99$, $p = .040$) with natural views being related to a higher course grade when compared with the concrete-view condition.

Discussion

As hypothesized, consistent with the existing literature on restorative window views, classrooms with visual access to a natural environment promoted positive classroom outcomes. Students with a natural view rated the course curriculum, classroom resources, and classroom materials more positively than students with no natural view. Objective indicators of classroom attendance and course grade were not wholly supportive of natural views, but final course grades were shown to be higher in the natural window-view condition compared with the concrete view. All those effects were shown after controlling for variability between sections, instructors, and beginning of semester course ratings for the individual and each section.

Taken together, this pattern of findings offers some interesting possibilities for real-world applications and raises questions for existing practices and research related to classroom design. As stated previously, a tradition within classroom architecture has emphasized windowless classrooms as a means for reducing student distraction. While not testing classrooms with or without

Table 2. Parameter Estimates for the Three Models Examining the Relationship Between Window View and Course Ratings and Outcomes.

		Course curriculum rating		
		Model 1	Model 2	Model 3
Fixed components				
Intercept	γ_{00}	3.57**	1.93	2.12
Classroom view (1 = natural)	γ_{01}			0.30*
Instructor	γ_{02}		0.02**	0.02**
Curriculum (section mean)	γ_{03}		0.13	0.17
Subject (section mean)	γ_{04}		0.18	0.05
Materials (section mean)	γ_{05}		0.01	−0.11
Enthusiasm (section mean)	γ_{06}		0.75**	0.86**
Building (section mean)	γ_{07}		0.32	0.07
Resources (section mean)	γ_{08}		0.20	0.08
Features (section mean)	γ_{09}		−0.79*	−0.59
Students (section mean)	γ_{010}		−0.56†	−0.43
Curriculum	γ_{10}		0.23**	0.23**
Subject	γ_{20}		0.11*	0.11*
Materials	γ_{30}		0.13*	0.13*
Enthusiasm	γ_{40}		−0.08	−0.08
Building	γ_{50}		0.03	0.03
Resources	γ_{60}		0.06	0.05
Features	γ_{70}		−0.08	−0.08
Students	γ_{80}		−0.00	−0.00
Variance of random components				
	τ_{00}	0.117**	0.029	0.018**
	σ^2	0.872**	0.787**	0.787**
Deviance (−2LL)		1537.261	1387.646	1382.289
		Classroom resources		
Fixed components				
Intercept	γ_{00}	3.26**	1.68	1.86
Classroom view (1 = natural)	γ_{01}			0.32*
Instructor	γ_{02}		0.00	0.00
Curriculum (section mean)	γ_{03}		−0.18	−0.15
Subject (section mean)	γ_{04}		−0.06	−0.20
Materials (section mean)	γ_{05}		0.01	−0.11

(continued)

Table 2. (continued)

			Classroom resources	
Enthusiasm (section mean)	γ_{06}		−0.01	0.10
Building (section mean)	γ_{07}		0.34	0.07
Resources (section mean)	γ_{08}		−0.35	−0.48
Features (section mean)	γ_{09}		0.15	0.36
Students (section mean)	γ_{010}		0.52†	0.67*
Curriculum	γ_{10}		−0.08	−0.08
Subject	γ_{20}		0.04	0.04
Materials	γ_{30}		0.04	0.04
Enthusiasm	γ_{40}		−0.03	−0.03
Building	γ_{50}		0.08	0.08
Resources	γ_{60}		0.29**	0.29**
Features	γ_{70}		0.11†	0.11†
Students	γ_{80}		−0.02	−0.02
Variance of random components				
	τ_{00}	0.108**	0.046*	0.033†
	σ^2	0.888**	0.744**	0.744**
Deviance (−2LL)		1550.801	1370.920	1365.729
			Quality of materials	
Fixed components				
Intercept	γ_{00}	3.52**	2.15	2.39†
Classroom view (1 = natural)	γ_{01}			0.49**
Instructor	γ_{02}		0.01†	0.01*
Curriculum (section mean)	γ_{03}		0.09	0.15
Subject (section mean)	γ_{04}		0.14	−0.05
Materials (section mean)	γ_{05}		0.22	0.02
Enthusiasm (section mean)	γ_{06}		0.40*	0.59**
Building (section mean)	γ_{07}		0.39	−0.03
Resources (section mean)	γ_{08}		0.33	0.13
Features (section mean)	γ_{09}		−0.69†	−0.37
Students (section mean)	γ_{010}		−0.62*	−0.41
Curriculum	γ_{10}		0.13†	0.13†
Subject	γ_{20}		0.12*	0.12*
Materials	γ_{30}		0.18**	0.18**
Enthusiasm	γ_{40}		−0.02	−0.02
Building	γ_{50}		0.01	0.01

(continued)

Table 2. (continued)

			Quality of materials	
Resources	γ_{60}		0.06	0.06
Features	γ_{70}		0.04	0.04
Students	γ_{80}		−0.07	−0.07
Variance of random components				
	τ_{00}	0.109**	0.046†	0.015
	σ^2	0.846**	0.772**	0.772**
Deviance (−2LL)		1519.364	1381.859	1368.490
			Final course grade	
Fixed components				
Intercept	γ_{00}	86.31**	84.12**	85.69**
Classroom view (1 = natural)	γ_{01}			1.99*
Section	γ_{02}		−0.01	−0.01
Instructor	γ_{03}		0.11*	0.13*
Curriculum (section mean)	γ_{04}		4.87*	4.94*
Subject (section mean)	γ_{05}		−1.46	−2.35
Materials (section mean)	γ_{06}		−5.10*	−5.69**
Enthusiasm (section mean)	γ_{07}		5.14**	5.78**
Building (section mean)	γ_{08}		4.28	2.46
Resources (section mean)	γ_{09}		−6.47*	−7.06**
Features (section mean)	γ_{010}		1.44	2.53
Students (section mean)	γ_{011}		−3.28	−2.23
Curriculum	γ_{10}		−0.77	−0.76
Subject	γ_{20}		0.62	0.61
Materials	γ_{30}		0.47	0.48
Enthusiasm	γ_{40}		−0.71	−0.71
Building	γ_{50}		0.30	0.30
Resources	γ_{60}		0.21	0.19
Features	γ_{70}		−0.08	−0.07
Students	γ_{80}		−0.09	−0.09
Variance of random components				
	σ^2	68.026**	62.390**	61.888**
Deviance (−2LL)		3902.941	3652.949	3648.725

†$p < .10$. *$p < .05$. **$p < .01$.

windows, the current study showed that view out the classroom window was associated with course-grade performance and subjective ratings. In the context of biophilia, the natural views could be lowering student stress, restoring student attention, and/or enhancing the overall mood, which translates into a better classroom experience and higher subjective ratings. Lower stress and enhanced mood could also account for the higher overall course grade that was shown at the end of semester.

The rejuvenation of the plants within the natural view that occurred during the second half of the term (mid-March to early May) could be responsible for the differences observed in final grades that were not present at midterm. Such conclusions are beyond the scope of our data but offer ample opportunity for future research. The views available, rather than the window itself, are worth considering when planning future classroom architecture. Research testing this possibility should be carried out to better pull apart the role of presence or absence of windows versus the presence or absence of natural views with regard to biophilic restoration and student distraction.

Although a conclusion that the outcomes are related to effects of the views on students would be consistent with prior research in nonclassroom settings, we cannot ignore the possibility that a natural view positively affects the instructor in a way that benefits course outcomes and subjective ratings. Regardless, the current study's findings suggest that educators should consider seeking out classrooms or learning environments with visual access to natural settings or features. The data show that students provided higher ratings for the course and also performed better on course assignments. Classroom access to nature could be accomplished via room scheduling, outdoor classrooms, field lectures, by bringing plants into the windowless lecture room, or by painting natural scenes on the walls. Similarly, students might consider the physical classroom environment when deciding between two sections of the same course, and students and instructors could be more likely to encourage course interactions that take place where natural views are present.

With that said, there are several limitations in the current study that warrant caution when interpreting and applying the data. These findings are limited to the outcomes assessed in this study. Other unmeasured factors, positive and negative, could be playing out as a result of the window view, and, without additional research, such effects are unknown. For example, natural views may promote positive moods or restore attention for students; such views may also distract instructors or cause decreased mood during winter sessions when the natural view is less vibrant or colorful.

Moreover, the current study used a quasi-experimental design meaning that course sections and instructors were not randomly assigned to the two window-view conditions. As such, variability in instructors and section enrollment could be driving some of the observed effects. However, initial comparisons showed no differences between sections on ratings and showed that conditions were comparable on many potentially confounding variables, and the multilevel modeling approach to the data analysis controlled for section and instructor variability. In addition, the current study was restricted to one course within one type of academic discipline. Composition course outcomes may not be affected by distraction or restorative views in the same way as other courses, such as math or history. Upper level courses requiring more expertise and that often use a different pedagogical approach may also be differentially affected by window views. Without research cutting across a wider range of disciplines and course selections, the idiosyncrasies unique to introductory-level composition courses cannot be pulled out or quantified. It is possible that these effects are weaker or stronger in other classroom situations or teaching styles. For example, courses in large lecture halls dominated by a screen for computer projection commonly do not have windows because the natural or electronic lighting can interfere with seeing what is on the screen.

Future research using additional outcomes such as instructor ratings of students or behavioral observations of student chatter, window viewing, disruptive behavior, or classroom discussion involvement would be a valuable next step. Given theoretical perspectives in restorative environment research, perceived stress or directed attention could be examined as likely mediators for the observed effects. Testing a wider range of disciplines or teaching styles is necessary to better understand the robustness of the effect and to explore additional variables that could be moderating the observed effects. Research using large contrasts between teaching styles (e.g., purely lecture based versus seminar discussions or laboratory sessions) and curriculum (e.g., technical versus artistic or humanities based topics) would be a useful next step related to that line of research.

In the end, this study adds to a growing body of work on nature views. Consistent with research in hospitals, office buildings, and residences, the current study found that visual access to natural views related to preferable psychological outcomes in college classrooms. Coupled with additional research, such findings have the potential to affect educational policy and practice, university architectural design, and overall academic achievement. They could also help justify the added costs associated with less traditional green spaces such as rooftop gardens or interior designs incorporating live trees or foliage.

Authors' Note

Grantees undertaking projects under government sponsorship are encouraged to express freely their findings and conclusions. Points of view or opinions do not, therefore, necessarily represent official Forest Service policy.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: This research was supported by Agreement No. 06-JV-11221617-233 from the USDA Forest Service, Rocky Mountain Research Station, Research Work Unit 4851.

References

Baird, C. L., & Bell, P. A. (1995). Place attachment, isolation, and the power of a window in a hospital environment: A case study. *Psychological Reports*, *76*, 847-850.

Bitgood, S. (2003). Visitor orientation: When are museums similar to casinos? *Visitor Studies Today*, *6*(1), 10-12.

Bringslimark, T., Hartig, T., & Patil, G. G. (2011). Adaptation to windowlessness: Do office workers compensate for a lack of visual access to the outdoors? *Environment and Behavior*, *43*, 469-487.

Devlin, A. S., & Arneill, A. B. (2003). Health care environments and patient outcomes: A review of the literature. *Environment and Behavior*, *35*, 665-694.

Edwards, L., & Torcellini, P. (2002). *A literature review of the effects of natural light on building occupants* (NREL/TP-550-30769). Golden, CO: National Renewable Energy Laboratory. Retrieved from http://www.scribd.com/doc/7687245/25/Windowless-Classrooms

Eisen, S. L., Ulrich, R. S., Shepley, M. M., Varni, J. W., & Sherman, S. (2008). The stress-reducing effect of art in pediatric health care: Art preferences of healthy children and hospitalized children. *Journal of Child Health Care*, *12*, 173-190.

Falk, J. H., & Balling, J. D. (2010). Evolutionary influence on human landscape preference. *Environment and Behavior*, *42*, 479-493.

Farley, K. M. J., & Veitch, J. A. (2001). *A room with a view: A review of the effects of windows on work and wellbeing* (IRC-RR-136). Ottawa, Ontario, Canada: National Research Council Canada, Institute for Research in Construction. Retrieved from http://www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/rr/rr136/rr136.pdf

Gulwadi, G. R. (2006). Seeking restorative experiences: Elementary school teachers' choices for places that enable coping with stress. *Environment and Behavior*, *38*, 503-520.

Han, K. T. (2007). Responses to six major terrestrial Biomes in terms of scenic beauty, preference, and restorativeness. *Environment and Behavior*, *39*, 529-556.

Han, K. T. (2009). Influence of limitedly visible leafy indoor plants on the psychology, behavior, and health of students at a junior high school in Taiwan. *Environment and Behavior*, *41*, 658-692.

Hayes, A. F. (2006). A primer on multilevel modeling. *Human Communication Research*, *32*, 385-410.

Heerwagen, J. H. (1990). The psychological aspect of windows and window design. In K. H. Anthony, J. Choi, & B. Orland (Eds.), *Proceedings of the 21st Annual Conference of the Environmental Design Research Association, EDRA 21/1990* (pp. 269-280). Oklahoma City, OK: Environmental Design Research Association.

Heschong Mahone Group. (1999). *Day lighting in schools*. Fair Oaks, CA: Heschong Mahone Group.

Heschong Mahone Group. (2003). *Windows and classrooms: A study of student performance and the indoor environment* (No. P500-03-082-A-7). Sacramento: California Energy Commission.

Kahn, P. H., Friedman, B., Gill, B., Hagman, J., Severson, R. L., Greier, N. G., & Stolyar, A. (2008). A plasma display window?—The shifting baseline problems in a technologically mediated natural world. *Journal of Environmental Psychology*, *28*, 192-199.

Kaplan, R. (1993). The role of nature in the context of the workplace. *Landscape and Urban Planning*, *26*, 193-201.

Kaplan, R. (2001). The nature of the view from home: Psychological benefits. *Environment and Behavior*, *33*, 507-542.

Karmel, L. J. (1965). Effects of windowless classroom environment on high school students. *Perceptual & Motor Skills*, *20*(1), 277-278.

Küller, R., & Lindsten, C. (1992). Health and behavior of children in classrooms with and without windows. *Journal of Environmental Psychology*, *12*, 305-317.

Langdon, F. J., & Loudon, A. G. (1970). Discomfort in schools from overheating in summer. *The Journal of the Institute of Heating & Ventilation Engineers*, *37*, 265-274.

Moore, E. O. (1981). A prison environment's effect on health care service demands. *Journal of Environmental Systems*, *11*(1), 17-34.

Shin, W. S. (2007). The influence of forest view through a window on job satisfaction and job stress. *Scandinavian Journal of Forest Research*, *22*, 248-253.

Snijders, T., & Bosker, R. (1999). *Multilevel analysis. An introduction to basic and advanced multilevel modeling*. Thousand Oaks, CA: SAGE.

Sykes, K., Gaffney, C., Sykes, T., & Posner, I. (2010). Sustainability in casino design and operation: "Green" is good for the bottom line. *World Journal of Science, Technology and Sustainable Development*, *9*(1), 64-72.

Tanner, C. K. (2009). Effects of school design on student outcomes. *Journal of Educational Administration*, *47*, 381-399.

Taylor, A. F., Kuo, F. E., & Sullivan, W. C. (2002). View of nature and self-discipline: Evidence from inner city children. *Journal of Environmental Psychology*, *22*, 49-63.

Tennessen, C. M., & Cimprich, B. (1995). View to nature: Effects on attention. *Journal of Environmental Psychology*, *15*, 77-85.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, *224*, 420-421.

Ulrich, R. S., & Lunden, O. (1990, June 27-30). *Effects of nature and abstract pictures on patients recovering from open heart surgery*. Paper presented at the International Congress of Behavioral Medicine, Uppsala, Sweden.

Walch, J. M., Rabin, B. S., Day, R., Williams, J. N., Choi, K., & Kang, J. D. (2005). The effect of sunlight on postoperative analgesic medication use: A prospective study of patients undergoing spinal surgery. *Psychosomatic Medicine*, *67*, 156-163.

Wilson, E. O. (1984). *Biophilia*. Boston, MA: Harvard Press.

Windhager, S., Atzwanger, K., Bookstein, F. L., & Schaefer, K. (2011). Fish in a mall aquarium—An ethological investigation of biophilia. *Landscape and Urban Planning*, *99*, 23-30.

Author Biographies

Jacob A. Benfield is an assistant professor of psychology at the Pennsylvania State University's Abington College, where he conducts research on environmental stressors (noise), privacy/territoriality, restorative environments, and applied social psychology.

Gretchen Nurse Rainbolt is an environmental psychologist who lives and works in Northern California. Her research covers topics such as sustainable behaviors, decision making, sustainable agriculture, and attitudes and values related to natural resources.

Paul A. Bell is an emeritus professor of social and environmental psychology at Colorado State University. His research includes noise and air quality in national parks, influences of territoriality and ambient temperature on aggression, and resource dilemmas.

Geoffrey H. Donovan has a bachelor's degree from Sheffield University in biochemistry and a doctorate in forest economics from Colorado State University. He works as a research forester for the USDA Forest Service's Pacific Northwest Research Station (since 2001). His two main research areas are the economics of wildfire and quantifying the benefits of urban trees.