Plant Power: The Impact of Plants in the Classroom on Student Success and Well-Being

Elizabeth Pitts
University of Mississippi. Sally McDonnell Barksdale Honors College

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PLANT POWER: THE IMPACT OF PLANTS IN THE CLASSROOM ON STUDENT SUCCESS AND WELL-BEING

by

Elizabeth A. Pitts

A thesis submitted to the faculty of The University of Mississippi in partial fulfillment of the requirements of the Sally McDonnell Barksdale Honors College.

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Approved by:

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Advisor: Dr. Carrie Veronica Smith

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Reader: Dr. Laura Johnson

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Reader: Dr. Kate Kellum
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ABSTRACT

ELIZABETH A. PITTS: Plant Power: The Impact of Plants in the Classroom on Student Success and Well-Being
(Under the direction of Dr. Carrie Veronica Smith)

In this study we investigated if there is a relationship between the presence of plants in the classroom and student success and well-being. Past research has found that the presence of plants in the workplace and home improves attention capacity, satisfaction, well-being, affect, fatigue levels, and social connectedness. Participants were 177 college freshmen in an honors discussion-based course. These classes were located in one of two nearly identical classrooms, with the differentiating factor being the presence of two flower pots on plant stands with Snake Plants and Heart Leaf Philodendrons. The participants completed a paper-based survey that assessed classroom behavior, academic engagement, satisfaction, motivational beliefs of self-efficacy, attention capacity, and positive and negative affect. This study found that the presence of plants in the classroom significantly and positively influenced student classroom behaviors (t(130) = -2.150, p = .033). This indicates that the presence of plants is positive for social connectedness and peer engagement. This is an important finding for a discussion-based course as it facilitates the cohesion of the classroom. Research should continue to investigate these findings and take into account our recommendations for future research.
Plant Power: The Impact of Plants in the Classroom on Student Success and Well-Being

Humanity has evolved with nature since its inception, and so it makes sense that nature would have a profound impact on humans. Wilson (1984) coined the term “biophilia” which describes humans’ innate tendency to gravitate towards life and its processes. Throughout his book, he described in detail humans’ fascination with plants, animals, and other living organisms. He argued that biophilia is one of the basic instincts of *Homo sapiens* that appears universally — geographically and temporally. Wilson (1984) employed an evolutionary theoretical framework to describe why today humans still recreate a landscape when they are deprived of greenery. He commented on humans’ tendency to decorate offices with indoor plants, create gardens, and add paintings of nature to their manmade environments. He hypothesized that humans are acting on a genetic memory of the ideal environment that their ancestors sought out.

Nearly a quarter of a century later, Grinde and Patil (2009) sought scientific evidence for the biophilia hypothesis through evaluating over fifty empirical studies regarding humans’ “inherent inclination to affiliate with Nature” and their affinity towards plants (p. 2332, Grinde & Patil, 2009). These included plants in various forms: indoor plants, views of nature, or being outdoors in a natural setting. They expanded on the importance of biophilia and concluded that the lack of an interaction with nature negatively impacts the human mind, which they term as ‘discord.’ Granted, not everyone is inclined to cultivate a garden or maintain a multitude of houseplants, but the general
consensus they reached is that people enjoy being around plants. The question is whether indoor plants impact students’ minds in ways that affect and benefit their classroom success and well-being. This study aims to examine whether indoor plants positively influence students’ experience in the classroom.

**Satisfaction.** A number of studies have found that the presence of nature positively impacts satisfaction, whether that be in the workplace, the neighborhood, or life satisfaction in general. Research has found that more greenery translates into higher levels of satisfaction, including greener window views, more indoor plants, or a greener landscape design versus a more urban design (Niewenhuis et al., 2014; Van Herzele & de Vries, 2012; Kaplan, 2001).

Kaplan (2001) was interested in the impact of natural window views from home and its impact on satisfaction. The study evaluated window views from inside apartment complexes and surveyed the residents. She found that participants with window views with natural elements had higher levels of neighborhood satisfaction and an improved sense of well-being. She further urged housing developers not to treat natural elements from the window views “as amenities but as basic to satisfaction and well-being” (p. 540).

Van Herzele and de Vries (2012) examined whether the presence of nearby greenspaces in the neighborhood affected satisfaction, happiness, and general well-being. The neighborhoods they studied were similar in a number of aspects, including socioeconomic levels, demographics, and housing conditions. They conceptualized ‘greenery’ as the number of nearby greenspaces that provided space for walking, such as parks and grassy areas, and streetscape greenery, such as tree-lined streets and front yard
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gardens. Participants were asked about perception of air quality, cleanliness, satisfaction with amount of greenery, and ‘niceness’ of the neighborhood. Residents of the green neighborhood indicated higher levels of neighborhood satisfaction. Of all the predictors, they found that satisfaction with the amount of greenery was the most indicative of neighborhood satisfaction. In conclusion, neighborhoods with incorporated green spaces and more streetscape greenery are correlated with higher levels of resident satisfaction with the community.

Attention. Several studies have applied the Attention Restoration Theory (ART) to measure the impact of plants on attention capacity (Lee et al., 2015; Kaplan, 2001; Raanaas et al., 2011; Evensen et al., 2015). This theory asserts that spending time in nature or looking at natural scenes improved peoples’ concentration by engaging involuntary attention and allowing the directed attention system to recover from fatigue.

Kaplan (2001) investigated the impact of nature on attention capacity, particularly which nature elements were most restorative. She coded window views for different nature elements such as trees, open grassy areas, shrubbery, and flowering varieties. She found that while window views of nature were significantly related to a variety of well-being factors, certain nature elements were in fact more predictive of improved levels of distraction in particular. Views of trees or farmlands (versus nature scenes such as formally landscaped areas of shrubbery, for example) were both associated with feeling less distracted. This study showed that the type of plant matters and can influence different outcomes on those exposed.

Lee, K. Williams, Sargent, N. Williams and Johnson (2015) were curious if ‘micro’ exposure to nature scenes restored attention capacity. Participants were either
exposed to a concrete roof top or a roof top with grassy vegetation for 40 seconds before continuing with cognitive tasks. The group who viewed the meadow demonstrated more consistency and completed the tasks with fewer omission errors. They concluded that even brief exposure to nature scenes indicated restored attention spans to some extent, and that exposure to urban scenes did not restore cognitive function.

Ulrich (1983) developed the Stress Recovery Theory (SRT), which states that natural environments reduce physiological stress and aversive in people. In short, people in natural environments will recover quicker from physiological stress than those in urban environments. Evensen, Raanaas, Hagerhall, Johansson, and Patil (2015) compared the restorative properties of plants versus inanimate objects using ART, as well as the SRT. The inanimate objects were similar to the plants in color and size. This study used two white and pink orchids and two green shrub-like plants. The inanimate objects include two lamps that replaced the orchids, a wooden bookshelf filled with blue and green journals, and a green binder on the desk. The studies included spaces with and without window views that offered a view of nature, including a tree. As predicted, participants that had both a window view and indoor plants had the most significant increase in task performance. However, they also found that mere environmental enrichment is also restorative – meaning that not only plants but also any inanimate object in the space could restore attention. In conclusion, window views of nature plus indoor plants are ideal for attention restoration, but inanimate objects can also offer some benefit.

**Affect.** Several studies have connected the presence of plants with increased positive affect and decreased negative affect (Van Herzele & de Vries, 2012; Chang & Chen, 2005). Increased positive affect and decreased negative affect are associated with
positive well-being outcomes (Fredrickson & Joiner, 2002). Van Herzele and de Vries (2012) questioned if the presence of nearby greenspaces in the neighborhood impacted happiness and general well-being. The neighborhoods were similar in a number of aspects, including socioeconomic levels, demographics, and housing conditions. They conceptualized ‘greenery’ as the number of nearby greenspaces that provided space for walking, such as parks and grassy areas, and streetscape greenery, such as tree-lined streets and front yard gardens. Of the 600 surveys that were distributed between the green and non-green neighborhood, they received 190 completed surveys with similar return rates for both neighborhoods. Residents of the green neighborhood reported higher levels of happiness and scored better on a general health scale.

Through a large literature review of the impact of plants on the human mind, Grinde and Patil (2009) also searched for an answer to this question of plants’ impact on the human psyche and affect. Evolutionary theory was one of the guiding frameworks for this study, rationalizing that the presence of nature has historically been a sign of prosperity for humans. For example, a green landscape indicated that food was ample. They concluded that an environment devoid of greenery is perceived as a stressor, negatively impacting affect.

While many of these studies used self-report methods, Chang and Chen (2005) wanted to know the psychophysiological response of people when exposed to nature. They simulated six combinations of office settings on computer software including window views of nature or a cityscape, indoor plants, no window views, and no indoor greenery. They used a biofeedback device to determine the stress level based on the psychophysiological response of employees. They found that window views of nature
produced the most positive effects, while the indoor plants also significantly improved anxiety levels. However, the combination of indoor plants and a nature window view produced the most favorable results. These various research methods bolster the hypothesis that plants positively impact affect and well-being.

**Peer Engagement.** A study by Niewenhuis et al. (2014) addressed several of the aforementioned measures, as well as peer engagement. They attempted to address the controversy on green versus lean office spaces after the British Prime Minister implored departments to cut frivolous spending on flowers and plants. They used identical, open plan office spaces for a natural experiment. They manipulated the environments by enriching the experimental workspaces with indoor plants or removing all greenery from the office. Their studies were a mixture of short and long-term projects. They administered surveys among employees with questions regarding employee engagement, workplace satisfaction, air quality, concentration, and workplace engagement. Improving these factors could translate into more efficient workplaces and increased revenue.

They found that greener workspaces were indicative of higher engagement among employees. While they did not explore this finding in depth, they suggested that it could be a possible mechanism for the other findings in their study regarding the impact of plants in the workplace. In particular, they found that increased employee engagement positively impacted satisfaction, concentration, and perceptions of air quality.

Green workspaces significantly increased workplace satisfaction in four out of their six studies. They found that engagement among employees may be a significant mechanism that increases workplace satisfaction.
Through three field studies they found that indoor plants led to more workplace engagement. More generally, employees in the green office had a “more positive orientation to their work environment and to their work” than the lean office employees (p. 210, Niewenhuis et al., 2014). They also hypothesized that it might be a cyclic effect – increased workplace engagement leads to more positive ratings of the work environment, which in turn leads to increased physical, cognitive, and emotional engagement at work. They concluded that greener offices are superior to lean offices.

**Academic engagement.** The current research aims to examine whether the aforementioned findings regarding the benefits of plant exposure can be extended to classrooms and the academic realm. No study has examined plants and these variables in a classroom situation or how plants affect student success. This study seeks to connect and contribute to these two fields of research.

Fredericks, Blumenfeld, and Paris (2004) reviewed the literature on academic engagement in an effort to clarify and validify the concept. In short, they described academic engagement as a multifaceted concept that involves the behavioral, cognitive, and emotional engagement of students in the classroom. Skinner and Kindermann (2009) hypothesized that an academically engaged student is emotionally engaged, meaning they are satisfied with the course, and behaviorally engaged, meaning they exhibit positive behaviors regarding the class material. While research regarding the impact of plants on academic engagement is scarce, research on plants and workplace engagement is more available. This study will apply those theoretical frameworks to evaluate the effects of indoor plants on engagement.
Classroom Design. K. Young, C. Young, and Beyer (2017) studied whether the physical classroom space affects student success. She conceptualized student success as lower failure rates, lower withdrawal rates, and higher attendance rates. Students completed open-ended surveys to share what they liked or disliked about their classroom, which was either a large auditorium (840 square meters) or a more intimate lecture hall (180 square meters). She found some indications that the more intimate classroom increased engagement among students. In other words, students were more engaged with the course when there was an increased sense of a community atmosphere, which can be manipulated through the design of the physical space.

Han, Kiatkawsin, Kim, and Hong (2017) studied the impact of the classroom’s physical environment on student satisfaction with the course. They surveyed students on their satisfaction, cognitive evaluation, and affective evaluation of the course. They found that classrooms with better ambient conditions, such as air quality, humidity level, and noise level, would be associated with higher satisfaction in the classroom. They confidently concluded that the physical classroom environment, specifically the ambient conditions and spatial layout, played a significant role in students’ course satisfaction levels. They also concluded that cognitive and affective evaluations were significantly indicative of the student’s satisfaction level with this course.

Current Study. This study was designed to determine if there is a relationship between the presence of plants in the classroom and student success and well-being. While the previous literature has not investigated the effects of the presence of plants in workplace settings in depth, the research on plants in the classroom is even more lacking. We wanted to investigate the impact of plants in the classroom on student success and
well-being to see if academic institutions could enhance student experiences with indoor plants. This research is important because children through young adults spend a great deal of their time in classrooms.

To conduct this study, we formed three hypotheses to guide this study. First, we predicted that students in the plant room will have more positive individual experiences, such as increased satisfaction, positive affect, and beliefs of self-efficacy. Next, we hypothesized that students in the plant room will have reduced negative experiences, such as negative affect and fatigue. Finally, we predicted that students in the plant room would perceive more positive classroom behaviors by their peers.
Method

Participants and Procedure

Participants were 177 freshman honors students in that were enrolled in twelve sections of the same course. The course was chosen because it was a discussion-based course, and part of the study sought to evaluate engagement in the class and between classmates. Participants were recruited to participate in the study by their professors who agreed to let the research group distribute the survey during their class period. Twenty-five instructors received the initial email explaining the study and invited to let their students participate. Of those 25, 14 were determined to be in classrooms that would qualify for the study once the university registrar released classroom locations. Those 14 received follow-up emails the month preceding the spring semester when the study took place. Two professors did not want to participate in the study. One professor did not want to participate because he did not want his students to feel pressured to take a survey since it was a small classroom setting. The other professor did not provide a reason for not wanting to participate. Twelve professors in total agreed to participate in the study and allow the research assistants to administer the survey to their students during an agreed-upon date.

The aforementioned “qualifying” classrooms were two classrooms that were identical in size, set-up, lighting, window placement, and general decor. They were also located on the same floor of the same building, with the windows affording the same view. They only differed in that the control room did not contain an additional door to the
outside, while the experimental room did. The experimental room also contained indoor plants. The plants are described in detail in the materials section.

The professors were asked not to bring attention to the plants in the classroom before the survey. Research assistants visited the 12 classrooms on three different dates during the third week of the spring semester, during the final ten minutes of the class period. Forty-four people’s data were deleted due to contamination of the data by a third party. The experimenters nor the participants were at fault. Due to causes out of our control, these 44 participants could have been aware of the plants’ role in the study, thus invalidating the data.

Participants were given an information sheet before completing the approximately 3-minute paper. The participants were assured that no one out of the research group would see their responses, including their professor. The students were not asked any identifying information regarding either themselves or their professors. We did not ask the participants for gender or race information because the small class sizes of thirteen to fifteen could have made the participants identifiable. The groups were predominantly Caucasian and some sections were overwhelmingly female (e.g. one class had only one male and fourteen females, all Caucasian). We did not ask for identifying information regarding the professors because this study did not seek to evaluate the professor of the class. The professors came from various disciplines and were of varying gender. However, they all were reputable instructors as they were all invited to teach this course. Neither the participants nor the professors were compensated in any form for their participation.
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Materials

The researcher placed two plants in opposite corners of the experimental room before the semester began so that all participants would be able to see a plant from their place in the classroom. Further, the potted plants were placed on stands to increase visibility. Each pot contained two different types of plants. *Sansevieria trifasciata*, more commonly known as a snake plant or mother-in-law’s tongue, was chosen as one of the plants for its easy-care regimen, durability, and noted ability to remove impurities from the air. Second, *philodendron cordatum*, more commonly known as a Heart Leaf Philodendron, was chosen for its easy-care and suitability to the respective environment (appropriate light and humidity levels). These plants were also chosen because the indoor varieties are non-flowering, thus preventing an allergen risk to the participants.

The self-report survey included a variety of questions that intended to measure the impact of plants on student success and student well-being. Student success was measured by student behavior, academic engagement, and motivational self-efficacy beliefs. Well-being was measured through fatigue, and positive and negative affect. A total of thirty-nine items comprised the two-page survey. The survey took approximately 3 minutes to complete. A copy of the survey can be found in Appendix A.

**Student Classroom Behavior Scale (Consortium on Chicago School Research, 2003).** This scale measures students’ perceptions of their peers’ behavior in the classroom ($\alpha = .736$). A high score indicates that students perceive more positive behaviors between classmates in the classroom, and a low score indicates that problematic behaviors are more prevalent. The 5 items included questions about how much students perceive their classmates care about each other, put each other down, get
along with each other, look out for themselves, and treat each other with respect.

Frequency is assessed on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree).

**Academic Engagement Scale (Consortium on Chicago School Research, 2003).** This scale is designed to measure students’ self-reported engagement and interest in the course ($\alpha = .817$). A high score indicates that students are more actively engaged in the class material. This subscale consisted of 5 items that were measured by a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The items included questions regarding the student’s interest or disinterest with the class topics and the student’s self-reported effort in the class.

**Engagement vs. Disaffection with Learning: Student-report (Skinner, Kindermann, & Furrer, 2009).** This scale used four subscales to measure behavioral engagement and disaffection and emotional engagement and disaffection. A high score indicates that students are behaviorally and emotionally engaged in the class. The scale included eight items measured with a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Behavioral questions pertained to student’s participation, concentration, and listening efforts in the class. Emotional questions included questions about whether the class is enjoyable, fun, or is worrisome to the student. See Table 1 for the reliability of each of these subscales.

**Motivational Beliefs – Self-Efficacy Scale (Pintrich & DeGroot, 1990).** This subscale came from a larger assessment that measured motivational beliefs and self-regulated learning strategies ($\alpha = .489$). A high score indicates that students have strong motivational beliefs of self-efficacy. We deemed the other subscales irrelevant to our
study because they focused on assessing students’ testing skills. The self-efficacy subscale was chosen to evaluate if plants impacted students’ beliefs about their own competency in the course. The scale used two items with a five-point Likert scale (1=strongly disagree, 5=strongly agree). With these items, we asked if students believed they could understand the ideas taught in the course and if they believed they would receive a good grade in the class.

**Fatigue Scale (Paul, Cohen, & Gilchrist, 2002).** This scale consisted of two subscales: cognitive and mental fatigue. This scale was developed to assess fatigue in people with myasthenia gravis, and so many of the items were omitted to make the scale more suitable for students. We chose four items from the cognitive fatigue scale and one item from the mental fatigue scale. A high score on the cognitive fatigue scale indicates that the student is suffering from a compromised attention span and decreased cognitive function (α = .824). A high score on the mental fatigue scale indicates that the student is drowsy. These subscales were chosen because they conceptually separated the ideas of cognitive and mental fatigue. The items utilized a five-point scale (1=very slightly or not at all, 5=extremely). The items inquired about sleepiness, motivation, attention span, concentration, and thinking clearly.

**PANAS: Manual for the Positive and Negative Affect Schedule (Watson, Clark, & Tellegan, 1988).** We selected 15 items from the PANAS scale and divided them into two subscales for positive and negative affect, with eight and seven items, respectively. A high score indicates a high positive or negative affect, respectively (α = .892, α = .682). These included measures such as, “Interested, Distressed, Enthusiastic,
Upset, etc." This portion also employed the five-point Likert scale (1=very slightly or not at all, 5=extremely).
Results

Independent sample t-tests were conducted to analyze the relationship between plants and each of the measures. The measures included classroom behavior, academic engagement, motivational beliefs of self-efficacy, cognitive fatigue, mental fatigue, and positive and negative affect. Descriptive statistics can be found in Table 1.

While several of the outcomes were not found to be statistically significant, the results were in the predicted direction. We hypothesized that students in the plant classroom would be more academically engaged than in the non-plant room; however the difference was not significantly different, \( t(95) = -0.28 \). Similarly, students in the plant classroom had lower negative affect scores than those in the non-plant classroom \( t(126) = 0.19 \).

On the other hand, other outcomes were opposite of the predicted direction; however, they were not statistically significant either. This study did not replicate previous findings that plants are restorative for attention capacity. Students in the plant classroom demonstrated higher levels of cognitive fatigue than those in the non-plant room \( t(130) = -0.43 \). Likewise, the participants in the plant room also exhibited higher levels of mental fatigue than participants in the non-plant room \( t(130) = -0.57 \).

While students in the plant classroom demonstrated lower levels of negative affect, they also demonstrated lower levels of positive affect than students in the non-plant room \( t(126) = 0.84 \), which did not support our hypothesis. Finally, we hypothesized that the presence of plants would improve motivational beliefs of self-efficacy. However,
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students in the plant room demonstrated lower levels than those in the non-plant room ($t(130) = 1.06$).

More positive class behavior existed in the plant classroom than in the non-plant classroom ($t(130) = -2.150, p = .03, d = .41$). This indicates that the presence of plants is positive for social connectedness and peer engagement. Further, student classroom behavior was significantly correlated with academic engagement, ($r(95) = .53, p < .001$), and motivational beliefs of self-efficacy, ($r(130) = .32, p < .001$).
Discussion

We conducted this research because we wanted to understand how educational institutions can use plants to enhance the classroom setting to improve student success and well-being. Universities should take an interdisciplinary approach to creating the most beneficial atmosphere for learning and for alleviating the systemic problem of mental health issues among students. While several studies have evaluated the impact of the presence plants in the workplace (Chang & Chen, 2005; Nieuwenhuis et al., 2014) and community (Kaplan, 2001; Van Herzele & de Vries, 2012), research has not investigated the impact of the presence of plants in the classroom.

With this in mind, we investigated if the presence of plants impacted student success and well-being. We hypothesized that the presence of plants in the classroom would lead to more positive individual experiences, such as increased academic engagement, positive affect, and beliefs of self-efficacy. Similarly, we expected participants in the plant group to have reduced negative experiences, such as decreased negative affect and fatigue. Finally, we predicted that students in the plant room would perceive more positive classroom behaviors by their peers. Our hypotheses were partially supported. Our findings did not support that the presence of plants impacts individual experiences in the classroom. We found no statistically significant differences between positive affect, self-efficacy, negative affect, or cognitive or mental fatigue. However, our study did support that students exposed to plants in the classroom perceive more positive classroom behaviors by their peers.
Despite these insignificant findings, we believe that the statistically significant finding with increased positive classroom behavior was notable for a few reasons. Consistent with Nieuwenhuis et al.’s findings (2014), the presence of plants positively impacted peer engagement. The scale for classroom behaviors was the only scale that assessed participants’ perceptions of their peers’ behavior instead of their individual experiences. Questions regarding classroom behaviors included “Students in this class don’t really care about each other, students in the class treat each other with respect, students in this class put each other down, students in this class don’t really care about each other, students in this class put each other down.” The questions included negative and affirmative statements. This suggests that while the plants did not influence individual affect or perceptions of the course, it influenced behaviors towards others in the classroom.

Further, this scale was the only one that had a significant effects size. This suggests that the difference between the two groups is consistent and large enough to be important. In comparison, none of the other scales reached the standard small effects size threshold, while the scale for positive classroom behaviors neared the standard medium effects size threshold. Finally, student classroom behaviors were significantly correlated to academic engagement and beliefs of self-efficacy. While the scales for academic engagement and self-efficacy were not statistically significant, this finding suggests increased positive classroom behaviors is connected to increased academic engagement and self-efficacy. For these reasons, we believe that this finding was not merely a chance finding but an indication of the effects of plants in the classroom.
Limitations. Several limitations existed in the study. While the course and course content were the same across the class sections, the professors differed between classes. Therefore, we could not account for the effects of instructor style and attitudes on the students. For example, a literature professor that employs discussion throughout many of their classes may have a more engaging teaching style than a chemistry professor that lectures during many of their courses.

We used two classrooms that were nearly identical; however, the plant classroom had an additional glass door to the outside (a view of concrete space underneath the patio on the main floor). This feature could have influenced results as research shows that non-natural views can negatively impact affect.

Because our methods included only honors students, we cannot be certain that these results would be replicated in a less homogenous sample. Honors students may naturally be more engaged in the classroom, limiting the variability in results. Further, the study did not collect data on gender or race due to the small class size and this institution’s demographics. These classes were majority Caucasian students with a larger percentage of females. However, we found no evidence in the literature that the impact of plants is experienced differently by race or gender. Next, the N-size was relatively small for the experimental group because nearly half of the plant data was contaminated by a third party. This lack of statistical power may account for the lack of statistically significant results.

Previous research has expressed that plants may impact well-being for a variety of reasons (improved air quality, aesthetic qualities, etc.) that we did not account for in this study. We did not have the tools to measure air quality in the rooms or to manipulate the
control room to maintain similar humidity and purity levels. We limited the plants to non-flowering varieties to prevent introducing allergens into the environment, but flowering plants may produce varied results due to their more pleasing aesthetic.

The data in this study is wholly self-report data from the students. We were not able to collect more naturalistic data on these classes for a variety of reasons. Because the classes we studied were discussion-based, we were unable to assess if plants affected test outcomes and absorption of material. Next, the classes had a strict two absence policy, and so we decided that it would not be beneficial to study if plants impacted attendance rates because the students were held to a high standard for attendance already. We were also limited in this aspect by time restraints in completing the project before the end of the semester.

Another considerable limitation of this study was the setting of this campus. The University of Mississippi is a notoriously beautiful and green campus. The Princeton Review named the University of Mississippi the most beautiful campus in the United States in 2011. For this reason, all of the students in the study were exposed to excessive green spaces and natural scenery before entering the classrooms. Nieuwenhuis et al. (2014) hypothesized that participants in the lean and green office settings both experienced an increase in workplace satisfaction because participants in the lean office may have been influenced by the presence of plants in common areas on their floor. Thus, even though they could not see plants from their work stations, passing the plants on their way to their desks may have produced these results. This hypothesis was supported when they removed all plants from the floor, reconducted the study, and found that the increased satisfaction disappeared from the lean condition. In conclusion, the lack
of statistical significance may be due to the influence of the campus greenery before the participants entered the classroom.

Finally, the results may not have been statistically significant due to the floor effect. Several of the measures lacked variation in their responses, including the negative affect subscale, academic engagement subscale, and fatigue subscales. For example, the minimum and maximum scores for the negative affect scale were six and 19. However, the median score was roughly eight for the plant and non-plant participants. This could potentially be hiding the more nuanced effects of the plants. Similarly, the results of the academic engagement subscale demonstrated a highly similar mean between the plant and non-plant participants on the higher end of the range. This could indicate that the questions were too broad to assess the effects of plants on academic engagement. Finally, the mean scores of the fatigue subscales were very close to the lower end of the possible scores, following the floor effect pattern of the previous measures. This study did not uphold the hypotheses that the presence of plants would increase academic engagement and decrease negative affect and fatigue.

Contrary to the Attention Restoration Theory and Stress Reduction Theory, the presence of plants did not significantly impact participants’ levels of cognitive or mental fatigue. The ceiling effect may be a factor in the lack of statistically significant results. The course used in this study was a primarily, if not entirely, discussion-based course. Thus, the course activities may not have been demanding enough on the students for the plants to be able to remedy an issue of reduced attention capacity.

Another possible reason is that the presence of plants simply was not large enough to cause an effect. While the plants were visible from any one vantage point in
the classroom, they might not have been large enough or numerous enough to cause the expected results. However, future studies should be cautious, as Evensen et al. (2015) warned that too many plants could be a source of distraction. This would be counterproductive since the plant intervention is focused on increasing attention.

We also had concerns about certain measures. For example, the measure for academic engagement included items that assessed both emotional and behavioral factors. This is important because this study found differences in behaviors but not in individuals' emotions. The negative and positive affect scales may have also included items that were unreasonable to expect after a class period, such as hostility and distress. Different items should be selected from the PANAS scale to evaluate expected emotions after a class, such as interest or tiredness.

**Future Research.** To gain a better understanding of the impact of plants on students, researchers could explore the impact of fake plants or flowering plants, as well. Investigating the effects of fake plants on student success and well-being would be especially interesting because fake plants would offer a more sustainable and easier way to incorporate natural elements into the classroom, as live plants require attention and specific environments. Studying the effects of fake plants may also offer a way for researchers to see if participants perceive increased air quality with the presence of fake plants. Finally, future research could replicate this study and add additional plants to investigate the relationship between the number of plants and related outcomes.

To further explore the impact of plants on concentration, future research should consider collecting naturalistic data such as attendance rates, failure rates, and withdrawal rates. Future research should study classes with relaxed or no attendance policies and
investigate if plants impact attendance rates. Future studies should also consider surveying or studying professors or teachers in the classroom. Professors may also be influenced by plants in the classroom which could affect students’ success in the course.

**Final Conclusions.** This study made a significant contribution to the research literature on the influence of indoor plants by applying workplace models to the classroom. This study showed that the presence of plants in the classroom positively impacts student classroom behaviors. This suggests that the presence of plants in the classroom contributes to a more engaging and socially connected environment. This finding is important in moving forward the field of plant research in psychology because it fills a gap in the literature about the effects of plants in academic environments. Future research should continue to investigate the impact of the presence of plants in the classroom to create a better environment for students.
References


Wilson, E. O. *Biophilia*. Cambridge, Massachusetts: Harvard University Press.
Table 1 *Descriptive Statistics for Subscales*

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<th>Subscales</th>
<th>α</th>
<th>d</th>
<th>Min</th>
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<th>M</th>
<th>SD</th>
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<td>.41</td>
<td>12</td>
<td>25</td>
<td>22.51</td>
<td>1.84</td>
<td>21.65</td>
<td>2.29</td>
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<td>3. Self-efficacy</td>
<td>.489</td>
<td>-.19</td>
<td>6</td>
<td>10</td>
<td>8.27</td>
<td>.90</td>
<td>8.45</td>
<td>.95</td>
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<td>4. Cognitive Fatigue</td>
<td>.824</td>
<td>.07</td>
<td>4</td>
<td>16</td>
<td>6.25</td>
<td>3.07</td>
<td>6.05</td>
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<td>5. Mental Fatigue</td>
<td>-</td>
<td>.10</td>
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<td>5</td>
<td>2.50</td>
<td>1.29</td>
<td>2.38</td>
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<td>6. Positive Affect</td>
<td>.892</td>
<td>-.16</td>
<td>8</td>
<td>39</td>
<td>23.23</td>
<td>6.04</td>
<td>24.29</td>
<td>7.02</td>
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<td>7. Negative Affect</td>
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<td>-.04</td>
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<td>19</td>
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<td>2.95</td>
<td>8.12</td>
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Table 2 *Correlations between subscales*

<table>
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<th>Subscales</th>
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<td>Student Classroom Behavior</td>
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<td>Academic Engagement</td>
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<tr>
<td>Self-efficacy</td>
<td>.323**</td>
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*Note.* *p* < .05, **p** < .01
Appendix A

Honors 102 Student Questionnaire

☐ Check the box to indicate that you are 18 years or older
Classroom number ______

How much do you agree with the following statements regarding this class?

1. Most students in this class: don’t really care about each other
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

2. Most students in this class: like to put each other down
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

3. Most students in this class: don’t get along together very well
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

4. Most students in this class: just look out for themselves
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

5. Most students in this class: treat each other with respect
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

6. The topics we are studying are interesting and challenging
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

7. I usually look forward to this class
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

8. I work hard to do my best in this class
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

9. I am usually bored with what we study in this class
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

10. I often count the minutes until class ends
EFFECTS OF PLANTS IN THE CLASSROOM

12. When I’m in class, I participate in class discussions.
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

13. I pay attention in class.
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

14. When I’m in class, I listen very carefully.
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

15. This class is enjoyable.
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

16. In this class, I do just enough to get by.
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

17. When I’m in this class, my mind wanders.
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

18. When I’m in this class, I feel worried.
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

19. This class is not all that fun for me.
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

21. I’m certain I can understand the ideas taught in this course.
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

22. I think I will receive a good grade in this class.
   [ ] Strongly Disagree [ ] Disagree [ ] Neither Agree nor Disagree [ ] Agree [ ]
   Strongly Agree

25. Do you currently have problems concentrating?
   [ ] Very slightly or not at all [ ] A little [ ] Moderately [ ] Quite a bit [ ] Extremely

26. Are you feeling less motivated than usual?
   [ ] Very slightly or not at all [ ] A little [ ] Moderately [ ] Quite a bit [ ] Extremely
27. Are you having problems thinking clearly?
   [ ] Very slightly or not at all [ ] A little [ ] Moderately [ ] Quite a bit [ ] Extremely

28. Is your attention span less than usual right now?
   [ ] Very slightly or not at all [ ] A little [ ] Moderately [ ] Quite a bit [ ] Extremely

29. Do you currently feel sleepy or drowsy?
   [ ] Very slightly or not at all [ ] A little [ ] Moderately [ ] Quite a bit [ ] Extremely

Indicate to what extent you feel this way right now, that is, at the present moment

1 - Very slightly or not at all
2 - A little
3 - Moderately
4 - Quite a bit
5 - Extremely

__ Interested  __ Enthusiastic  __
__ Distressed  __ Irritable  __
__ Excited  __ Alert  __
__ Upset  __ Inspired  __
__ Strong  __ Nervous  __
__ Hostile  __ Determined  __
__ Jittery  __ Attentive  __