# The Impact of Living Green Walls on Student Attitudes, Moods, and Academic Performance

**A Grant Proposal**

**submitted to the**

## National Foliage Foundation

**Submitted by:**

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## I. Introduction

The physical environment where one lives, works and plays can impact the lifestyle, health and productivity of individuals (1). University students are frequently under stress as they make their way through their daily academic and personal responsibilities; achieving academic excellence, meeting financial obligations and balancing work, social, and academic demands. Stress can negatively affect the health and academic performance of students. This project will alter the physical space within a university classroom by adding a living green wall of foliage plants. We will conduct surveys of students and instructors who utilize the classroom with the green wall and those using a comparable, unmodified classroom to determine how the physical modification impacts psychological and academic factors.

This project intends to provide empirical evidence of the significance of the presence of a living green wall of foliage plants on students in an academic setting. The additional documentation of the positive impact that plants have on the attitudes, moods, productivity and well-being of humans could be used to promote expanded use of foliage plants in the indoor environment. The results could also lead to an expanded utilization of living green walls in indoor academic and business settings and, hence, expand the demand for and utilization of foliage plants.

## II. Review of Previous Research

A building is not truly green until plants are included in the interior. There is increasing scientific evidence to support the premise that the presence of plants can improve human health and well-being. A number of studies have shown that the presence of plants enhances oxygen levels in the environment, sequesters carbon, filters pollutants from the air, lowers blood pressure, decreases anxiety, enhances worker concentration, promotes more rapid healing and creates a more productive work environment (1).

NASA researchers evaluated the use of plants as air purifiers in the 1980s and discovered that many indoor tropical foliage plants have the ability to filter air more efficiently than any mechanical filter (1). Their research resulted in the recommendation that one six-inch potted foliage plant per one-hundred square feet of floor space can significantly improve the indoor air quality. In 1990, Prescod tested a broad range of tropical foliage species and developed a list of

the most effective plants for purifying the air and which pollutants they remove (6). Plants filter many volatile organic compounds from the air including xylene, carbon dioxide, benzene and formaldehyde. Lohr and Pearson-Mims (4) found that indoor plants also reduced the number of particulates in the air.

There is also evidence that the presence of plants improves human physical and mental health. Kaplan's work suggests that the natural environment has a restorative effect on humans and can promote the recovery of the capacity to focus attention (3). Lohr et al demonstrated that the presence of plants in the workplace reduced stress levels, reduced systolic blood pressure and increased workplace productivity (5). Research in 2002 by Shibata and Suzuki demonstrated that undergraduate students performed better on association tasks when they were in the visual presence of plants (7). Ulrich's research revealed that college students under exam stress had increased positive feelings and reduced anxiety and anger when they were in a room with a view of plants compared to no plants present (1). Similar findings were found during Frank's research in 2003 (2). All of these previous studies were completed using movable potted plants. The psychological impact of the presence of a living green wall on student performance, which is the subject of this proposed project, has not previously been tested.

Incorporating plants into the interior space of a classroom is not easily accomplished however. Administrators are obliged to get as many seats in the classroom as possible and to fill the room to capacity in order to meet budget and facility constraints. Mobile pots and planters of foliage plants rob valuable floor space, are too easily vandalized and are frequently mismanaged when left in the care of untrained custodians. Poorly maintained plants can look worse than having no plants at all in a space. However, the recent development of vertical living green wall systems that are clean and have self-sustaining, automated irrigation, present a new opportunity for integrating green plants in places with limited space, including classrooms.

Living vertical green wall (or green wall) systems are commonly planted with a variety of non-allergenic foliage plants. Systems have been developed in several countries around the world in order to provide living green walls that enhance indoor air quality. They have been acknowledged by the LEED process as positive additions in the indoor landscape of office buildings and public spaces. One of the leading indoor vertical wall experts in the United States, McRae Anderson of McCaren Designs, Inc., has installed his wall system in numerous locations across the country and one recently in the newly renovated Ford building by Target Field in Minneapolis, MN. This is the system that we will install and use for this project.

## III. Proposed Research

**Objectives:**

This project will test for empirical evidence that the presence of a living green wall of foliage plants benefits students and instructors in an academic setting. The results will add to the understanding of the role of plants on human performance and well-being in the interior environment. Results showing a positive correlation between the presence of a living green wall and student and instructor well-being and performance, could lead to an expanded utilization of living green walls in the interior and hence, increased demand for and utilization of foliage plants.

This project will alter the physical space of one university classroom by adding a living green wall of foliage plants. Students and instructors who utilize the modified space and those in a comparable unmodified classroom, will be surveyed to determine how the physical modification and presence of plants impacts student mood, motivation, anxiety, calmness, attention level, academic performance and feeling of productivity.
Undergraduate students will gain undergraduate research experience by being involved with multiple aspects of the project including wall design, wall installation, survey development, survey implementation and survey data analysis. This will not only provide students a great undergraduate research experience but it will also provide experience with a living green wall system, a real-world horticultural application of plants that could lead to future career opportunities.

## Materials and Methods:

### Personnel

Three University of Wisconsin - River Falls (UWRF) faculty members will contribute to the project along with undergraduates from their academic programs. Dr. Terry Ferriss, Professor of Horticulture, Certified Professional Horticulturist, will serve as the principal investigator. Ferriss will coordinate the installation of the living green wall and be active in the survey process. Dr. Travis Tubre, Professor of Psychology, and Dr. David Trechter, Professor of Agricultural Economics and Director of the University Survey Research Center, will have primary responsibilities for survey development, implementation and analysis. As an industrial psychologist, Dr. Tubre has conducted previous research on workplace productivity. Dr. Trechter's Survey Research Center conducts between 30 and 40 surveys each year and has extensive experience in survey design and data analysis. Undergraduate students will work actively alongside the faculty throughout the project starting with the design of the wall through dissemination of findings at the end of the project.

### Partners

Dale Gallenberg, Dean - College of Agriculture, Food and Environmental Science, oversees the physical and academic activities in the Agriculture Science Building including the scheduling of which classes are taught in which rooms. He has already approved the use of the classroom (Room 331 AGS) and the installation of the living green wall for this project. His enthusiasm for the project is reflected by a commitment of $1000 from College funds for project related expenses. The use of a second classroom (Room 333 AGS), a room that has the identical physical layout as Room 331 AGS, has also been approved. Room 333 AGS will be a comparison room for conducting parallel surveys, thus creating a control group for evaluating and validating survey results.

The UWRF Physical Facilities department has already approved the installation of the living green wall system and agreed to assist with the installation process. The campus as a whole is committed to sustainability. The University Center is a Silver LEED Certified building and there is campus support for promoting new initiatives that are environmentally and sustainably proactive. The UWRF Physical Facilities department will coordinate the installation of lighting, placement of a vapor barrier, installation of wall anchors and the prefabrication and installation of the catch basin for the water and soffit to top-off the wall. Expenses related to these installation costs will be paid for by this project.

The Undergraduate Research and Scholarly Activity program at UWRF has also demonstrated support. They have awarded Mallory Westlund and Brittany Rootes, undergraduates in Horticulture, $750 for purchasing supplies to support this project. This is the maximum amount that can be awarded to any one undergraduate research project.

McRae Anderson at McCaren Designs in Minneapolis, MN, has agreed to support this project. McCaren Designs will provide the *wall panels* for the living green wall system at a 50% discount. He is actively seeking additional support from the Green Plants for Green Buildings LEED Advocacy Committee to secure funding for the remaining cost of the *wall panels*. McRae Anderson has also agreed to donate his services to work with the students on the development of a plant design that will be successful in the specific classroom site location.

<u>Wall Installation</u>

The Greenwalls Vertical Planting System of McCaren Designs (see Appendix 1) will be installed along a 14 ft. sidewall of the classroom (Room 331 AGS). Eight panels, each 3 ft. x 3 ft., will be mounted on the wall resulting in a planting area of 6 ft. x 12 ft. or 72 sq. ft.. The prefabrication and installation of the catch basin (13 ft x 16 inches x 16 inches) for water, the 6-8 inch soffit above the wall and the lighting will be coordinated by the UWRF Physical Facilities department.

The initial design of the plant layout will be done by an undergraduate Horticulture major who has already completed the HORT 245 Interior Plantscapes class. McRae Anderson will provide consultation and recommendations for the final design. A combination of 3 inch and 4 inch plants will be used, depending upon species and cultivar of plant specified by the design. Given a 72 sq. ft. planting area, an estimated 288 three-inch foliage plants and 216 four-inch foliage plants will be installed into the design.

The wall will be installed during the week of spring break, March 17-21, 2014.

Survey Design, Implementation and Analysis

The UWRF research protocols require that any time human subjects are used in a research project, the research protocols intended to be used must be reviewed and approved prior to the initiation of the project. The IRB Human Subjects Research Review Protocol has already been submitted and has been approved for this project. The actual surveys to be used in the project will be submitted prior to implementation for final approval.

Ferriss, Tubre, Trechter and selected research project undergraduates, will collaborate to develop the actual surveys to be administered to various groups of students. Some surveys may be given to students who are invited in as a focus group while others will be enrolled in classes in the two rooms to be used in this study. The opportunity to administer surveys in two identical rooms (Room 331 and 333 AGS) with only one of the rooms having a living green wall is a great survey advantage in the long term.

A Horticulture faculty member who teaches multiple sections of Introduction to Plant Science has already volunteered to teach one section in Room 331 and the other in room 333 for a controlled survey opportunity on student performance. In the short term, the installation of the wall will not take effect until the middle of the spring semester so students in Room 331 can be surveyed before and after the installation of the wall.

The surveys will attempt to determine the effect of the presence of a living wall of plants on student mood, anxiety, concentration, and academic performance. During the fall 2014 semester, Ferriss, Tubre and Trechter will work with the Associate Dean of CAFES to schedule sections of multiple classes in the two rooms that are taught by the same instructor (e.g. two sections of Introduction to Plant Science taught by the same instructor, two sections of Agricultural Economics I taught by the same instructor, etc.)

Survey questions may include but are not limited to (responses will be a Likert scale with appropriate descriptors – e.g. strongly agree to strongly disagree):

1. I feel more relaxed in this classroom than in other classrooms.
2. It is more difficult to focus in this classroom compared to other classrooms.

3. I feel more content in this classroom compared to other classrooms.
4. The distractions in this classroom are greater than in other classrooms.
5. The presence of indoor plants affects my mood negatively.
6. How much time do you spend outdoors a week , on average?
7. The behavior of students in this room is better than in other classrooms.
8. What is your grade level (freshman, sophomore, etc.)?
9. Is this course required for your major or an elective?

In addition, short standard psychological tests can be administered that evaluate one's ability to concentrate, take-in and recall information. Survey results will be analyzed through the UWRF Survey Research Center.

Dissemination of Research Results

The results of this research will be disseminated through Horticultural, Educational and Psychological venues. An annual progress report will be submitted to the National Foliage Foundation in October 2014 with a final project report submitted by March 2015. The results will be available for NFF use.

We will seek to publish results in peer reviewed Horticultural Science journals through the American Society for Horticultural Science, Journal of Environmental Psychology and/or in the North American Collages and Teachers of Agriculture Journal. Articles could also be submitted to Horticultural trade journals including publications via Meister Publishing and Grower Talks via Ball Publishing.

Oral presentations of the results will be proposed for the Northern Green Expo (an annual Green Industry Conference in Mpls, MN, sponsored by the MN Nursery and Landscape Assn.); the PLANET Interiorplantscape Conference at Longwood Gardens; and at the Annual American Society for Horticultural Science Conference. Additional dissemination of results at national psychology conferences and on the UW-River Falls campus will also be made.

Efforts will also be made to disseminate the information to the general public through sharing results in the popular press and on internet sites.

Undergraduates will have an opportunity to present posters related to the project outcomes at the UWRF Undergraduate Research and Scholarly Activity Day; at the National Undergraduate Research and Scholarly and Creative Activity Conference; and at the annual conference of the American Society for Horticultural Science.

## IV. Importance and Potential Value of the Proposed Research to the Foliage Industry

This project seeks to expand and enhance the functional use of foliage plants by documenting the benefits of having plants in the learning environment. The positive impacts of plants on human productivity, health and well-being are not intuitive to the general public. It is critical that research provide empirical data to document any statistical significance associated with the presence of plants in the human environment, including the impact of foliage in the interior environment. This project will expand the understanding of the benefits of the presence of living green walls in the academic learning environment.

Research results could also lead to a heightened awareness of interior living green walls and an encouragement for greater utilization of the walls and hence simultaneous expanded use of foliage plants. Historically academic buildings have not taken full advantage of the potential benefits of integrating plants in the interior, the results of this project could help to draw additional attention to the value of including foliage plants in the design and layout for places of learning.