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For the degree of Master of Science

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HOW MUCH DO U.S. UNIVERSITY STUDENTS KNOW ABOUT SUSTAINABILITY AND GREEN BUILDING? THE FINDINGS OF A SURVEY AND POSSIBLE IMPLICATIONS FOR GENERAL ELECTIVE CURRICULUM AVAILABLE TO ALL STUDENTS AND DISCIPLINES.

A Thesis

Submitted to the Faculty

Of

Purdue University

By

Jeremy Ray Farner

In Partial Fulfillment of the

Requirements for the Degree

Of

Master of Science

May 2011

Purdue University

West Lafayette, Indiana

To my wife and best friend, Heidi-for her patience, love, and unwavering support in all that I do.

To my kids, Annee, Ellee, Dodge, Sailor, Linen, & Scout- for their prayers and understanding to live without Dad for 2 years.

To my parents-for being my biggest cheerleaders and encouraging me to never stop learning.

To my Sibling, Friends and Colleagues-for their words of encouragement to stay motivated.

ACKNOWLEDGMENTS

There are many who have been instrumental in the creation of this work, many of whom probably do not fully know or understand their impact. Words do not seem to express my gratitude for the many who have willingly given input or suggestions at different times throughout the process. Many whom I am unable to name have given words of encouragement or a lifting voice of perspective when the task felt overwhelming and impossible to complete.

Nevertheless, I would like to begin by thanking the members of my committee for their guidance, support, encouragement, criticisms, and suggestions. As my chair, Kirk Alter not only advised me on my subject, in which he is a renowned expert, but also on life in the academic world. I will be forever grateful for his insight and perspective.

To a dedicated friend and colleague who served as my research assistant throughout the data collection and analysis process, Andrew Pratt: Thank you for your efforts and input. This would not have been possible without you. A giant thank you is also due to all who proof read my paper and gave insightful feedback and encouragement to not give up! (Joe Orczyk, Daphene Koch, Pieter Van der Have, and various colleagues and classmates in the BCM department at Purdue)

Finally, to my best friend, greatest fan, and love of my life, I thank my wife Heidi for her unwavering support. For the countless hours of frustration, taking care of the kids alone, and lifting up my spirits throughout the entire process, she is much more deserving of this degree than I.

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LIST OF ABBREVIATIONS

AFUE- Annual Fuel Utilization Efficiency

ANSI-American National Standards Institute

BCM- Building Construction Management

BTU- British Thermal Unit (the amount of energy needed to heat 1 lb. water 1º F.)

CFL-Compact Florescent Light bulb

CGB- Certified Green Built

CGP- Certified Green Professional

DOE-Department of Energy

EIA-Environmental Information Administration

EPA –Environmental Protection Agency

EPA- Environmental Protection Agency

FMI-Industry research group for Construction

GDP- Gross Domestic Product

GSA- General Services Administration

HEFCE- Higher Education Funding Council for England

HERS- Home Energy Rating System

HVAC- Heating, Ventilation, and Air Conditioning

ICC-International Code Council

IECC- International Energy Conservation Code

IRC-International Residential Code

LEED- Leadership in Energy and Environmental Design

MCGP- Master Certified Green Professional

NAHB- National Association of Home Builders

RESNET- Residential Energy Services Network

ROI-Return on Investment

R-Value- Resistance to heat flow (Usually insulation rating) (Thickness/Thermal Conductivity)

SEER- Seasonal Energy Efficiency Rating

SHGC- Solar Heat Gain Coefficient (the fraction of incident solar radiation admitted through a window)

USGBC- United States Green Building Council

U-Value/ Factor-Coefficient of heat transmission (Inverse of R-value or 1/R value)

VOC's-Volatile Organic Compounds

WCED- World Commission on Environment & Development

WSU- Weber State University

ABSTRACT

Farner, Jeremy Ray. M.S., Purdue University, May 2011. HOW MUCH DO U.S. UNIVERSITY STUDENTS KNOW ABOUT SUSTAINABILITY AND GREEN BUILDING? THE FINDINGS OF A SURVEY AND POSSIBLE IMPLICATIONS FOR GENERAL ELECTIVE CURRICULUM AVAILABLE TO ALL STUDENTS AND DISCIPLINES. Major Professors: Kirk Alter, Daphene Koch, Wesley Crawford

Using the survey approach, this investigation examined the attitudes and *interest* of college students at two universities in different geographic locations within the United States. Approximately 24,000 students from all disciplines and majors at Weber State University (WSU) in Utah, and 4,000 at Purdue University in Indiana, were invited to participate in a study to determine current *knowledge*, *familiarity*, and *interest* in topics within the sustainability and Green Building educational arena. The goal of this study was to determine what students already *know*, would like to *know*, and how much *interest* there would be in developing a general elective course offered to students from all majors on sustainability in the built environment. Currently, neither university offers such curriculum generally: it is limited to students in the architecture, construction management, or engineering programs to receive general elective credit towards graduation. The theory is that students from all disciplines are *interested* and would take a general elective course based on Green Building in the built environment concepts. The title of the course could potentially be; “How to Green Your Home”. Based upon the survey results and analysis, several outcomes suggest that students across all majors are indeed *interested* in greening their built environment. The data highlights what is currently understood, as well as areas in which education may be lacking. This contribution includes an outline of teaching implications as well as recommendations as to what, how, and where Green Building should be taught at the college level. The findings of this study suggest that a general elective course, multi-disciplinary in its approach, is both needed and wanted by university students.

CHAPTER 1. INTRODUCTION

Green Building and sustainability are common terms used in the architecture and construction industries, but are recently being used in almost every industry including retail, manufacturing, and the marketing sectors. This chapter will establish significance of college curriculum and the role it plays in the sustainability movement. Sustainability is a broad spectrum of thinking and action and therefore this paper will only address the aspect of sustainability or Green Building in the built environment and more specifically what we can do in our homes to be greener. It is important to lay the groundwork of what students already *know* and understand as well as develop a plan or curriculum to educate them on aspects of the movement they may not understand. This chapter will address the scope, purpose, research questions, assumptions, and limitations. Lastly, this chapter will conclude with a brief overview of the study.

1.1. Objectives

The overall goal of this research was to determine what student across all majors and disciplines *know* and want to *know* more about sustainability or Green Building in the built environment. Once it was discovered what students are familiar with and desire more *knowledge* on, curriculum could be developed that was multi-disciplinary to meet the needs of general education requirements. The steps and objectives were as follows:

1. Analyze a good cross section of the student population which included more than just the architecture, construction, and engineering disciplines to determine if there was *interest* in sustainability and Green Building. An analysis of what students were already

familiar with, and in what areas they were lacking, was needed to determine a plan that would lead to the development of a multi-disciplinary curriculum that could be offered as a general elective at the university level.

2. Develop a curriculum that touches or will touch on all aspects of Green Building and sustainability in the built environment. The curriculum should include all motivational areas found within the Green Building arena such as *economic*, *social*, and *environmental* analysis and application.

3. Create separate pools of data where cross analysis could be completed. For instance, the geographic analysis could identify areas in which current curriculum is sufficient as well as areas in which the content could be modified based on the data collected in each area. The survey questions were adapted from a similar study done in the United Kingdom (UK) to understand levels of *knowledge* and attitudes of sustainability in university students. The data can further be analyzed to determine if there are any national trends existing regarding how well sustainability is currently being taught in our educational systems.

4. Verify that sustainability and Green Building are on the minds of students at the university level and it is of *interest* to them to learn more about the technology and its implications in our built environment.

1.2. Background

As an undergraduate, I was fascinated by building efficiency and how to maximize it. After college, a goal was to leave my mark on the design industry by learning and applying the

latest and greatest technologies that would lead to a more efficient and higher quality product. I found many organizations and outlets there were for improving a process or design of components in a product whether that is a home or an engineered design of a mechanism. This led to participation in conferences, trade shows, and stay in tune with the latest improvements in technology through journals, training, etc. This passion for continuous learning and improvement led me to just such a program to study in greater depth. The ENERGY STAR program, sponsored by the United States government, was created to encourage home owners to be more efficient in their use of energy and water.

As a member of the architectural design community, I have the responsibility to educate the general public about the advantages and costs associated with the efficiencies of HVAC, windows, insulation, appliances, lighting, etc. My curiosity led me to discover there is a lot of information about green or sustainable building, but most people do not really understand what it is. It is about much more than just being energy efficient: It is a whole new paradigm of thinking that usually has its greatest benefits if it can be designed in from the start rather than retrofitted later.

Upon entering the academic sector, I quickly realized that my assumption that most people do not really understand what Green Building is was justified. Students seemed to have a good attitude about the concept but failed to understand its application and effects. Before I could attempt to answer the common question I get from students: “Is it really worth it? Isn’t it expensive?” I determined I first had to find out what they already *knew* and what they needed to *know* before I could let them answer their own questions.

My theory was that homeownership is something most people strive for in life and would be faced with decisions as to the types of products and design they would incorporate into their homes. At the university level, students are the next generation of home buyers. The college experience is meant to prepare students for the "real" world, so educating students on the meaning of sustainability and Green Building would better prepare them for home ownership.

1.3. Significance

Although there is a significant amount of Green Building literature, little emphasis has been placed on educational curriculum for green or sustainable building practices. There is little information about what university students *know* or have an *interest* in learning about the growing movement we call "going green". All indicators show that public awareness of the Green Building movement is continuing to grow (Vonasek & Warnock, 2008). It seems that everyone from homebuilders to major manufacture's of cleaning products is going "green" these days. This is evidenced by television commercials and advertisements for products all claiming to be green. "Architects, engineers and specifiers are requesting more certified woods and wood products as well as other green materials as more of them are being educated through various media and classes on Green Building" states Doug Martin, Pollmeier Inc.'s president of sales and marketing. (Vonasek & Warnock, 2008) The flashy topics of "Green Building" or sustainable design have transformed into a movement that is redefining all aspects of design and construction. It has moved past the fad stage and is here to stay (Oliver, 2007).

One of the major challenges of the Green Building movement is education. There are a lot of misconceptions that surround Green Building like; "It is too expensive", "It doesn't really

work", or "It takes 20 years to make it *economical*". One hurdle is educating the public about the various programs, product certifications and government regulations. Even though more and more people are becoming familiar with the term "green", they tend to still be a long way from *understanding* everything it encompasses (Vonasek & Warnock, 2008). "We believe that the most challenging aspect is education. There are still misconceptions about Green Building, which is understandable since it is a new way of thinking and a new way of building," stated Ashley Katz, media coordinator for the U.S. Green Building Council (USGBC, 2009).

The question then arises, what should be taught at the university level about Green Building? The starting point for developing a comprehensive and utilitarian curriculum in Green Building is determining what current students *know* about it. This must be coupled with an in-depth analysis of the major aspects of Green Building. Once a comprehensive list is assembled, the current student *knowledge* vs. the consensus of industry experts and educators can be analyzed to determine disparities. A recent study in the UK shows that education for sustainable development currently enjoys huge momentum with international strong political will and commitment to integrate this education at all levels including higher education (Fumiyo, 2007).

The importance of education on such a broad topic was evidenced in the establishment of the United Nations Decade for Education for Sustainable Development (2005-2014). One expert stated that the decade". . . offers academe's best chance to date for making the deep and radical changes that will be necessary if the world's higher education institutions are to enact their responsibilities for creating a better and self-sustained world" (Haigh, 2005). "Within the next ten years, the higher education sector . . . will be recognized as a major contributor to society's efforts to achieve sustainability- through the skills and *knowledge* that its graduates learn and put into practice" (HEFCE, 2005). Institutions such as colleges and

universities are key in educating society about and promoting application of the principles of sustainability (Katherine & Angela, 2006). Researchers around the world agree that the world's universities need to be the ones to educate society about sustainability, in order to implement a change in values (Forrant & Pyle, 2002; Sharp, 2002; Kliucininkas, 2001; Fihlo, 2000; Simon-Brown, 2000; Van Weenen, 2000). There is no better way to give future home owners the skills and *knowledge* they need to make "green" or sustainable decisions about their homes and environments they live in each day.

1.4. Statement of Purpose

The purpose of this study is to investigate the perceptions, *knowledge*, and/or *knowledge* gaps of a large cross section of the student population from all disciplines or majors at two different universities in the United States. The schools are geographically separated which allows the analysis of the differences in existing *knowledge* and experience of the respondents from each university. A third control group, from an existing study done in the UK of similar scope, could be used to validate the findings. The purpose was to determine what is currently being taught, and to identify deficiencies around which a general elective course curriculum could be created. The general core breadth course is a multi-disciplinary study and therefore could potentially fit into many areas such as life science, physical science, humanities, or social science. The determination of where this course best fits is beyond the scope of this paper and therefore will not be addressed.

1.5. Research Questions

The questions central to this research were based upon establishing the significance of college curriculum and the role it plays in the sustainability and Green Building movement. The questions are as follows:

1. What are students' *understanding* of sustainability and Green Building?
2. What are students' attitudes towards and concern with respect to sustainability or Green Building challenges?
3. What actions are students prepared to take, or have taken, towards realizing a more sustainable lifestyle?
4. How would the ranking of personal vs. perceived general societal motivation be different in regards to why individuals choose to go green in their built environment?
5. Is Green Building worth it, and what is an acceptable time limit to see a return on investment?
6. What do students report as their background (gender, affiliation with their school i.e. freshman-graduate student, age, and previous exposure to formal curriculum teaching sustainability in other fields) that could have contributed to their *familiarity*/ *understanding* and *interest* levels in learning more about sustainability or Green Building?
7. Determine specific areas within sustainability and Green Building with which students are most familiar and have the most *interest* in learning more from the follow list of 16 items; Passive Solar Heating/ Cooling, Geothermal Heating/ Cooling, Indoor Air Quality, Glazing (window) Efficiency, Appliance Efficiency, Insulation Ratings, Solar Hot Water Heating, Solar Power (Electricity Generation), Sustainable or Renewable Construction

Materials, Recycled/ Reused Building Products, Water Conservation, Wind Power, Hydro Power, Lighting Efficiency, NAHB Certified Green Built Homes, LEED for Homes.

8. What are overall *interest* levels of students from all disciplines in taking a course potentially entitled “Ways to Green Your Existing or Future Home”?

1.6. Assumptions

The following assumptions were inherent to the pursuit of this study:

1. There was a need to examine the current *knowledge*, *knowledge* gaps, and perceptions of students to gain insight into the need and *interest* of providing a curriculum at the university level to address sustainability and Green Building.
2. Participants would respond accurately and honestly to the survey questions posed concerning their own experiences, *knowledge*, and background within the sustainability and Green Building spectrum.
3. Students will be familiar with Windows-based operating systems to enable them to navigate the internet based survey that is to be distributed through their email accounts as part of their association with the university.
4. Students are willing to participate in an unpaid survey and answer questions posed in the survey honestly and openly.
5. Students will only participate in the survey once as to not disproportionately affect the outcomes. (Due to the anonymity requirements of the IRB approval process, this was not addressed.)

6. There will be proportionate participation in the study to adequately determine the general pulse of student perceptions and *knowledge* in regards to the topics of discussion.
7. The number of respondents will be sufficient to enable cross analysis between the existing study done in the UK and the data collected at Purdue University and Weber State University, respectively.
8. The chosen research methods for the study were appropriate to answer the research questions posed.
9. The survey questions were sufficient to establish a baseline to analyze students' current *knowledge*, *knowledge* gaps, perceptions and misperceptions in regards to sustainability and Green Building.

1.7. Limitations

The following limitations were inherent to this study:

1. The study invitees at Weber State University were limited to the number of students enrolled during the fall semester of 2010. (Approximately 23,000)
2. The study was limited to 4,000 invitees at Purdue University due to a limit placed on number of solicitations to participate in a survey set by the administration.
3. The study would be less valid if the total response rate fell below the expected outcome of 1000 respondents (Preferably equal numbers from both institutions).

4. If the respondents were heavily weighted in a particular area of study as to inadequately show the general student populations perceptions and *knowledge* of the topic of inquiry.

1.8. Delimitations

The following delimitations were inherent to this study:

1. The software Qualtrics will be used at Purdue University to deliver, store, and analyze respondent data.
2. The software Survey Monkey will be used at WSU to deliver, store, and analyze respondent data.
3. A single email invitation sent to students' university email through local list servers was used to solicit respondents using an HTML link to the 3rd party's software website.
4. A follow up email invitation was sent 2 weeks following the initial email.
5. The study will not identify the level of formal education that has been available to students and the participation in such education opportunities.
6. The study will not address the ethnic or social status of the students.
7. The study will be limited to universities found in two distinct geographical locations in the United States. Utah and Indiana are the only locations being surveyed and thus may not adequately reflect the perceptions and attitudes of students in other locations throughout the United States.
8. The study will be limited to an initial analysis of all questions answered and not include a follow up study to determine if students' perceptions and *knowledge* would change

after being subjected to an educational environment where the opportunity to participate in “green” education was afforded them.

9. A period of one month was allotted to the invitation and collection of data through the third party software collection agencies.

1.9. Definition of Key Terms

Green Building – the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. A Green Building is also known as a sustainable or high performance building. (Green Building, n.d.)

Sustainability- a method of harvesting or using a resource so that the resource is not depleted or permanently damaged. A lifestyle involving the use of sustainable methods and materials.

(Sustainability, n.d.)

Likert scale- a psychometric scale commonly used in questionnaires, and is the most widely used scale in survey research, such that the term is often used interchangeably with “rating scale” even though the two are not synonymous. When responding to a Likert questionnaire item, respondents specify their level of agreement to a statement. The scale is named after its inventor, psychologist Renis Likert. This type of scaling is based on attitudinal statements on the survey object ranging from one extreme to the other of agreement (Naoum, 2007).

1.10. Overview of Study

There are very few studies that have been done in regards to sustainability or Green Building educational needs, desires, and methods. Although several experts believe that for the Green Building movement to ultimately succeed in changing behavior, rather than just emotions or perceptions, it has to be understood at a deeper level than is currently believed to be the case (Katharine & Angela, 2006; Vonasek & Warnock, 2008). If education is the key to success, a qualitative study to determine *understanding* of Green Building concepts had to be done in the same setting in which the educational platform would be provided for the development of the curriculum. This study aims to prove that the university setting is the proper place for this to occur. This is based on the assumption that students are entering into a new segment of their lives where perspectives begin to change. Students are starting to think more about their future, career options, living situation, etc. Sustainability and Green Building have a lot to do with all of these choices that students face.

Each of the questions posed in the study are intended to reveal the current level of *knowledge* and *interest* in a multi-disciplinary course. The topics where knowledge gaps or *interest* exists could be addressed as part of the general education offered to all students on university campuses. The theory this study aims to prove is that more than just architecture, engineering, and construction students are *interested* in Green Building and sustainability. Another theory to be proven is that there are a lot of misconceptions and confusion surrounding the topics of sustainability and Green Building. These misconceptions could and should be addressed formally in the university setting as to prohibit a biased view of the technology and elements thought of as being green. The study aims to create a baseline upon which curriculum can be developed to address the current *knowledge* and/or *knowledge* gaps of university

students in regards to sustainability and Green Building. The course could be developed to lessen the formality of accepted scientific courses offered at the university level by including a multi-disciplinary method taking into account much more than the typical 3 motivational factors to go green: *economic*, *environmental*, and *social* (Fumiyo, 2007).

1.11. Organization

This thesis provides six major chapters and several appendices. Chapter 2 provides an overview of the Green Building and sustainability movement and industry. It begins with a brief historical overview which is further broken down into three main research areas:

- What do university students *know*/ want to *know* about Green Building?
- Defining Green Building; who is in charge?
- Green Building by the numbers; is it worth it?

Chapter 2 discusses the importance of developing a course for all students at the university level that fills in the gaps of *knowledge* and awareness towards the sustainability and Green Building movement.

Chapter 3 provides an overview of the methodology and framework used in this study, and aims to delineate the qualitative methodologies employed.

Chapter 4 is an analysis of the findings and a detailed explanation of the data and an analysis of the data using cross tabulation of responses. The cross tabulation is used to show a correlation between various facets of the study. For example, is there a relationship between

age and a student's attitude towards sustainability and Green Building? The following information is described in detail: demographics of the respondents, background information of participants, patterns of responses, and detailed comparisons of *knowledge* vs. *interest* in learning more about particular topics found within Green Building.

Chapter 5 provides a detailed analysis of themes that emerge from the results of the study. The chapter introduces each theme and how it affects the development of curriculum designed to meet the needs of students' education in sustainability and Green Building.

Chapter 6 is a summary of the study and its implications on general education offerings at universities across the country. It is the conclusion of the study, suggesting further analysis that could be done, and recommending the additional research that needs to be done to verify the outcomes of this study in other geographic locations throughout the U.S.

1.12. Summary

This chapter has provided an overview to this research project including demographics, background, significance, purpose, research questions, and scope definitions. The next chapter will outline the history of Green Building education and develop current and future directions of general education aimed at bridging the gap of students' current *knowledge* and conceptions.

CHAPTER 2. REVIEW OF THE LITERATURE

Research concerning Green Building or sustainability in the built environment has a long history. Sustainable building practices have existed in some form since the start of time. In fact, many of the building practices embraced within the Green Building movement are a return to methods of the past such as rammed earth, straw bale, and cob home construction. This chapter provides an overview of Green Building and its effects on construction.

2.1. Introduction

Although there is a significant amount of research and information on what "Green Building" or sustainability includes, there are limited publications exploring what students already *know* and want to *know* (Carew & Mitchell, 2002). An academic literature search using the databases available through the library search engines at Purdue University provided the major subsections of this review of the literature found on Green Building as follows:

- Green Building Overview
- What do university students *know*/ want to *know* about Green Building?
- Defining Green Building, who is in charge?
- Green Building by the numbers, how big is it?

2.2. Green Building Overview

If you ask the general public what green or sustainable building is, you are more than likely to get the response that the home is more efficient or is environmentally friendly than comparable homes in the area. How much do we really understand about Green Buildings: how they work, how much they cost, the advantages and disadvantages of owning one, or the real meaning of "going green"?

How much do we really want to know? Who is qualified to teach us what sustainable or green is? We need a source that is unbiased and does not have a hidden agenda. It cannot be from homebuilders or manufacturers of a product who have their personal *interest* in selling their products. This creates a need for a general source of education to be provided to university students, or the next generation of homebuyers and business owners. This is a non-biased platform where Green Building practices and ways to green an existing or future home can be examined. The approach could be multi-disciplinary to address *social*, *economic*, and *environmenta*l issues that arise when building using sustainable or green practices.

The past decade has seen a lot of excitement and emphasis placed on what is being termed the *green movement*. We are "greening" everything, from the products we used to clean our homes to the products used to build our homes. Green Building is an *economic* and *environmental* solution to the difficulties faced in the construction industry.

The construction industry is directly tied to the economy as is evidenced in the recent downturn in construction activities across all segments since the recession started in 2008. The recession has taken its toll on almost every aspect of the industry from marketability to profitability. The recession has brought to light a lot of the driving forces behind sustainability

and Green Building. For example, the impact of U.S. buildings on natural resources breaks down as follows:

- 40% primary energy use (Energy Information, 2008)
- 72% electricity consumption (Energy Information, 2008)
- 39% Carbon dioxide emissions (Energy Information, 2008)
- 13.6% potable water consumption (US Geological Survey, 2000)

Globally, buildings rank #1 for carbon dioxide emissions by sector (Energy Information 2006). It has also been documented that in the U.S. people spend, on average, 90% or more of their time indoors and that Green Buildings typically have better indoor air quality and lighting (Environmental Protection Agency, 1987). If more time is spent in buildings, people become more cognitive about issues within the building such as day lighting, indoor air quality, and efficiency. All of these are drivers of the green movement, but are more emphasized in the current economy. The recession has made everyone look a little closer at their spending and is forcing a deeper analysis to determine what is going to set their buildings apart from the others. Finding ways to be more efficient is the key to having long term success. As better technology and science evolve, we need to improve our end deliverables to the consumers: the buildings we occupy 90% of each and every day. Construction is a science, and therefore can be improved by using better materials, products, waste management, and active and passive design techniques. Green Building is just another name for quantifying an effort to promote continual improvement.

Green Building has been shown to reduce many byproducts of the construction industry including energy usage, carbon dioxide emissions, water usage, and solid waste (GSA Public

Building Service, 2008; Turner & Frankel, 2008). These byproducts of construction make up a substantial portion of impacts on our environment, as shown below.

- 12% water use (Kats, 2003)
- 39% Carbon dioxide emissions (Kats, 2003)
- 65% waste output (Kats, 2003)
- 71% electricity consumption (Kats, 2003)

Green Buildings can greatly reduce various areas found within the construction and management of buildings as shown in the research numbers below.

- Energy Use 24%-50% (Kats, 2003; Turner & Frankel, 2008)
- Carbon Dioxide Emissions 33%-39% (GSA Public Building Service, 2008; Kats, 2003)
- Water Use 40% (Kats, 2003)
- Solid Waste 70% (Kats, 2003)

Motivations to green our lives stem from one of three main concerns: *economic*, *environmental*, or *social* concerns (Fumiyo, 2007). The perceived benefits to green construction and buildings are as follows:

- 8%-9% Operating cost decrease (McGraw-Hill Construction, 2008)
- 7.5% building value increase (McGraw-Hill Construction, 2008)
- 6.6% Return on investment improves (McGraw-Hill Construction, 2008)
- 3.5% Occupancy ratio increase (McGraw-Hill Construction, 2008)
- 3% Rent ratio increase (McGraw-Hill Construction, 2007a)

Unless it makes sense *economically*, there is little chance to get a building owner in this economy motivated to incorporate Green Building design features. As shown above, operating costs or lifecycle costs are substantially lower with a Green Building, which helps to speed up

the return on investment (ROI). In buildings that are well ventilated and have ample day lighting, tenants seem to have more success (USGBC, 2009). To give this some context, more than 55 million students and 5 million faculty, staff and administrators attend schools each day. That is more than 20% of America's population that is spending up to 6 hours a day in a school building (USGBC, 2009). According to the United States Green Building Council (USGBC), "Green schools have a significant contribution to make in improving the health and well-being of America's students and the faculty and administrators who guide them." $35 billion is spent annually on K-12 schools to operate and be built. (Kats, 2003) A study done for California's Sustainable Building Taskforce was done to determine if LEED schools were cost effective to build. The study involved 30 schools across the country. The cost savings shown below are reflective of newly constructed schools where integrated design could be coupled with building science to create the greatest ROI and streamline opportunities that can reduce the cost of Green Building up to 40% (Kats, 2003). Findings of the study included energy and water savings of:

- 33.4% Average direct energy savings (Kats, 2003)
- 50% Average indirect energy savings (Kats, 2003)
- 32.1% Average water savings (Kats, 2003)

One of the biggest *economic* concerns is energy efficiency which has been one of the driving forces behind the green movement. The U.S. government's "ENERGY STAR" program has helped inform consumers about what their utility bills are really costing them, and that there are alternatives to paying high utility bills, resulting from the increases in costs for natural resources used to heat and cool their homes. Comfort issues stemming from heating and cooling homes are great motivators for homeowners to demand improved efficiency in air

handling systems. These demands are best met using the building envelope approach to control comfort whether it is being cool in the summer or warm in the winter. Insulation and air tightness become issues that are addressed as well as appliances and other energy consumers in the home.

Environmental concerns about our carbon footprint are expressed in television commercials and print challenging us to decrease or footprint and be aware of what we consume and discard in our daily lives. There is a new awareness about how lifestyle affects global climate and society as a whole. *Social* concerns are evidenced in the recycling movement that has changed waste management. The fad of going green has turned the corner and has become very prevalent in the policies of our government and regulations we all live under, impacting many aspects of our lives. Our generation could easily be known in the history books as the tax rebate or incentive generation. There are many federal and local initiatives, designed to encourage owners and builders to embrace the Green Building movement, offering incentives and third party certifications verifying that a home is in fact more green than a typical home meeting the minimum code requirements. The question is: which of the motivations really works to change the behavior or lifestyle of the next generation of homebuyers?

Some feel that *economic* incentives can and will have a positive influence on behavior, leading to a more sustainable development of our homes and lives, but this has not been definitively proven in research (McKenzie-Mohr, 2000). Other researchers believe that attitudes can only change through instruction and behavior intervention (Ma & Bateson, 1999). Most studies conclude that behavior change, in regards to sustainability, is neither easily understood nor easily manipulated (Katharine & Angela, 2006). If the end goal in green or sustainability

education is to change behavior, a deep *understanding* of the multifaceted motivations that lead to action in the green movement is necessary.

There is a unique mix of questions that need to be answered as to what is currently understood and what needs to be taught concerning Green Building in the future. Universities are the unbiased platform to present the fast paced industry of Green Building and sustainability in the built environment. When it is all said and done, college age students are the future consumers of products and homes who can make a significant impact on how sustainable our communities can be. They are the future policy makers and consumers that can enter the world to make well educated decisions about the direction of the US economy.

2.3. What do Students *Know* and Want to *Know* about Green Building?

Sustainability or Green Building has gained great momentum in changing the way we build and live our lives. We are more conservation minded in our approach to consumption as well as daily living. The World Commission on Environment and Development defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their needs" (WCED, 1987, p. 43). In a study to determine student's perceptions of sustainable development and sustainability the majority of students think sustainability is a good thing, but that this did not correlate with their degree of *familiarity* with the concepts of sustainable development or sustainability. Students associate the concepts with their *environmental* aspects as opposed to their *economic* and *socia*l aspects. The students were more likely to have "light green" actions they were willing to take such as changing shopping habits, recycling, and energy saving (Fumiyo, 2007). A survey of students was conducted at the University of Plymouth in 2007 to discover "current *understandings* and

perceptions of, and attitudes towards, sustainable developments, and related concepts and issues (Fumiyo 2007).

The three key research questions were:

1. What are students' *understanding* of sustainable development and sustainability?
2. What are students' attitudes towards and concerns with respect to sustainability-oriented challenges?
3. What actions are students prepared to take towards realizing a more sustainable lifestyle?

My study used similar research questions to determine the extent of students' *knowledge* and *knowledge* gaps pertaining to sustainability and Green Building. A survey of two geographically separated universities in the United States was used to compare and contrast two distinct groups of students. (Weber State University, Ogden Utah, USA; Purdue University West Lafayette Indiana, USA) The varying attitudes and *knowledge* of sustainability and Green Building practices among participants will be able to be analyzed.

Further research, conducted by Azapagic (2005) similar in scope to my study, set out to explore the *understanding* of sustainability held by engineering students, and suggested the following findings:

- Students felt sustainability was important despite their lack of *knowledge* of sustainability (Azapagic et al. 2005).
- Students felt that sustainability was more important for the next generation than their own (Azapagic et al. 2005).

- Students' *knowledge* on *environmental* issues was strong, but a gap existed in the *social* and *economic* aspects of their *knowledge* (Azapagic et al. 2005).

An Oxford University study indicates that a large portion of those surveyed felt that *environmental* concerns are the most important aspects of sustainability whereas economic concerns was close behind. The *social* aspect of sustainability is shown to be important to less than half of the respondents. About one third of respondents felt all three were equally important (Summers et al. 2004).

Another study by Darnton (2004) acknowledged that the *knowledge* and *understanding* of sustainability within the general population was also done. The *knowledge* deficit in regards to sustainability was acknowledged when it concluded that public awareness "runs less than 30 percent" (Darnton, 2004). In one survey, less than 20 percent of respondents who claimed to be aware of sustainable development that could actually give an explanation of the term. Darnton (2004) goes on to point out that the term sustainable development is a "conversation stopper" or a "turn off" for members of the public (Darnton, 2004). In other words it is a popular movement, but very few really understand it and how it works. There is an educational gap that needs to be addressed for students and the general public to become more acquainted and enthusiastic about sustainability and Green Building.

2.4. Defining Green Building: Who is in Charge?

Who is ultimately in charge of defining what building green really means? There are a lot of statistics and promises that are associated with sustainability and Green Building, but they all must be quantified in order to be valid. This has taken different forms over the years, but the

two main certifications are the USGBC LEED program and National Association of Home Builders (NAHB) Certified Green Built program. Is Green Building simply using more recycled products in our homes? Is it being more efficient in our energy consumption, or is it reduced water and natural resource usage, or is simply just being sensitive to the impact our homes have on the environment? Who is defining what is considered to be green?

Some say that energy efficiency benefits define whether it is a green built product (Oliver, 2007). Others say that as long as 21-30% of the materials used in the project are of green origins (i.e. reforested wood products etc.) it is a green home (Oliver, 2007). If, as a marketer, you are not using the "green" label, you are losing out on a large majority of the public who are demanding builders be more efficient and responsible in building. Marketing approaches vary greatly when embracing the new "green" movement. "Going 'green' will save green" is one of the potential slogans used to lure prospective clients. Green marketing has increased sales traffic according to a local study of real estate brokers (Oliver, 2007). In 2006, 2% of the residential market had at least one Green Building element which accounts for 2 billion dollars of the market (McGraw-Hill, 2007b). Most homebuyers perceive that "green" building increases project costs by 3-10%, where builders tend to think the percentage is much higher after incorporating soft costs of trial and error, etc. Builders tend to favor the opinion that homeowners are not willing to pay the full costs of going "green" and that the jury is out on whether or not (given the proper education) they actually would pay more for "green" features (Oliver, 2007). 61% of the public feel they are more energy conscious than 5 years ago, but 41% can't name a single source of renewable energy. 90% think the government should do more to deal with the energy crisis, and 77% are open to buying more green products (Shelton Group, 2009).

The most recognized and utilized resource in the U.S., relating to residential structures, is the "ENERGY STAR" program which essentially gives incentives to homes that are built more efficient than current code requires. To earn the ENERGY STAR label, a home must meet strict guidelines for energy efficiency set by the U.S. Environmental Protection Agency (EPA). These homes are at least 15% more energy efficient than homes built to the 2004 International Residential Code (IRC), and include additional energy-saving features that typically make them 20–30% more efficient than standard homes" (ENERGY STAR, 2011). "ENERGY STAR is a joint program of the U.S. EPA and the U.S. Department of Energy helping us all save money and protect the environment through energy efficient products and practices" (ENERGY STAR, 2011). The program was started by the U.S. EPA in 1992 as a voluntary program to promote energy-efficient products to reduce greenhouse gas emissions. Computers and monitors were the first products targeted to be replaced with more energy efficient models followed quickly by household appliances such as old refrigerators or freezers. The program expanded in 1995 to include office equipment, residential heating and cooling equipment. Starting in 1996 the EPA partnered with U.S. Department of Energy (DOE) for particular product categories. The ENERGY STAR label was created and is now on major appliances, office equipment, lighting, home electronics, and new homes, commercial and industrial buildings. The program estimates it saved businesses, organizations, and consumers about $17 billion in 2009 energy costs. ENERGY STAR is the driving force behind technological innovation such as efficient compact fluorescent lighting (CFL), power management systems for office equipment, and low standby energy use (ENERGY STAR, 2011). There are now over 60 product categories listed on their website WWW.ENERGYSTAR.GOV . On criticism of this federal incentive program is that is does not take

into any other considerations the home may have incorporated, other than actual energy efficiency performance done by a third party verifier (Schmidt, 2008).

Nationally, groups such as NAHB and the USGBC have developed standards that take into consideration much more than just energy efficiency. The NAHB partnered with the International Code Council (ICC) to develop the "Green Building Standard" that is now nationally recognized as the authority to administer certification in residential construction. The ICC 700 National Green Building Standard earned the approval of the American National Standards Institute (ANSI) in February, 2008. It is the foremost green rating system in the United States for new and remodeled residential and multi-family buildings and subdivisions. 46% of builders surveyed feel that a national certification is necessary (Oliver, 2007). The strategic plan of the NAHB's Green Building Standard is shown in figure 2.1 below. As evidenced below, the NAHB takes a more holistic approach to certifying a project is green.

NAHB Green was unveiled to provide a set of comprehensive educational resources, a credible green standard with which to measure, advocacy tools, and a referral system to guide potential homebuyers to third party certified professionals. NAHB feels that some of the impetus for the Green Building movement is being dictated by policy makers, but increased consumer awareness is also driving growth in the sector. "The more consumers are exposed to the benefits of green homes, the more demand we will see" (NAHB Green, 2011). There are four levels of certification starting with the Standard or Bronze level, Silver, Gold, and Emerald level.

Green Building means incorporating environmental considerations and resource efficiency into every step of the home building and land development process to minimize environmental impact. It's a practical response to a variety of issues that affect all of us – like increasing energy prices, waning water resources, and changing weather patterns. It means making intentional decisions about:

- ***Energy efficiency** improvements such as high levels of insulation, efficient HVAC systems, high-performance windows and energy-efficient appliances and lighting*
- ***Water conservation** measures such as water-efficient appliances and fixtures, filtration systems, and drought resistant or low-maintenance landscaping*
- ***Resource conservation** using materials and techniques such as engineered wood and wood alternatives, recycled building materials, sustainably harvested lumber, and more durable products*
- ***Indoor environmental quality** considerations such as effective HVAC equipment, formaldehyde-free finishes, low-allergen materials, and products with minimum off-gassing or low volatile organic compounds (VOCs)*
- ***Site design** planning such as minimizing disruption and preserving open space*
- ***Homeowner education** through manuals and operating guides*

Figure 2.1 NAHB Green Building methodologies (NAHB Green, 2011)

NAHB Green facilitates the increasing *interest* in sustainable construction by developing measurements of Green Building, educating and credentialing building professionals, and advocating at the national level for Green Building initiatives (NAHB Green, 2011). The Certified Green Professional (CGP), and Master Certified Green Professional (MCGP) are designations that can be earned by completing coursework and examinations. The designations are meant as a means for building professionals to demonstrate their expertise in Green Building. Along with these designations, NAHB Green offers venues such as the National Green Building Conference and the International Builders' Show, promoting continuing education in an evolving industry.

The USGBC has their LEED certification which encompasses the definition and certification of what "green" building is in both commercial and residential construction. LEED is

internationally recognized as the Green Building certification system. According to their methodologies third-party verification that a community or building is designed and built using their metrics is necessary to determine what is deemed green, and to what level it is green. Their metrics include water efficiency, energy savings, carbon dioxide emissions reduction, stewardship of resources and sensitivity to their impacts, and improved indoor environmental quality (USGBC, 2011).

The major sections of LEED scoring are found within the following 5 categories that determine the level of Green a building is certified to be; Site Planning, Water Management, Energy, Material Use, and Indoor Environmental Quality.

According to the USGBC, LEED was developed to "provide building owners and operators a concise framework for identifying and implementing practical and measurable Green Building design, construction, operations and maintenance solutions" (USGBC, 2011). LEED is designed to be flexible enough to apply to all building types, including commercial and residential. It is set up to work throughout the building's life cycle from design and construction, operations and maintenance, tenant occupancy, and through retrofit or remodel (USGBC, 2011). The mission of the USGBC is "to transform the way buildings and communities are designed, built and operated, enabling and *environmentally* and *socially* responsible, healthy and prosperous environment that improves the quality of life" (USGBC, 2011). The USGBC has four levels of LEED certification:

- LEED Certified
- LEED Silver

- LEED Gold
- LEED Platinum

LEED for new construction was first released in 2000 by the U.S. Green Building Council (USGBC, 2009). LEED for homes was launched in December of 2007.

According to Lockwood, it only costs .8% more to achieve basic LEED certification (Lockwood, 2006). "Green" buildings cost 20% less to operate by lowering overhead costs, promoting greater employee productivity, creating less absenteeism, and encouraging stronger employee attraction and retention (Lockwood, 2006).

2.5. Green Building by the Numbers: How big is it?

The Green Building construction environment comprises 13.4% of the $13.2 trillion U.S. gross domestic product (GDP) (Department of Construction, 2008). Further construction has an output of $4.6 trillion which translates into about 8-10% of the global GDP. This encompasses a workforce of 120 million people (McGraw-Hill Construction, 2008). Green Building construction in the U.S. is projected to increase to $60 billion in the new construction sector, and $240 billion in the renovation sector. Commercial and Institutional projects are expected to increase to $20 billion while residential will rise up to $40 billion (McGraw-Hill Construction, 2008). It is projected in 2011 10% of new commercial construction starts will be green (USGBC, 2009). The USGBC has registered LEED projects in all 50 states and 91 countries. The number of LEED accredited professionals is now 81,155 and 94,916 have attended their certification workshops. The number of people attending "Green Build" conventions is rising, which is impressive

considering the current economic state of construction in America. The number of people attending Green Build in 2007 was 22,835 and 28,224 in 2008 (USBC, 2009).

The construction industry is being held to a higher standard of performance than ever before. The general public's perception and expectations have changed with the introduction of the fast paced educational environment of our economy. Whether it is consumer reports, or specialists that provide information to consumers, builders are faced with the challenges of providing near flawless execution of construction at more competitive pricing than ever before. The construction industry has to look for new technology and methods that we can change or implement to satisfy the elevated expectations of our consumers. Energy efficiency has been the cheapest and largest resource to satisfy growing demands of owners for energy related services in the US economy (Laitner, 2009). Energy efficiency is in many ways an invisible energy resource that we just need to tap in to in order to lessen the burden placed upon our natural resources (Laitner, 2009). Energy usage has been ever increasing since the industrial revolution, and the advances in technology have helped to offset the total consumption increase. Gains in energy efficient practices can provide up to one-half of the needed greenhouse gas emissions reductions most scientists say are needed between now and the year 2050 (Laitner, 2009). Investments in more energy-productive and efficient technologies can lead to a substantial net energy bill savings for the consumer and for the nation's businesses. Technologies such as wind, solar and hydro power generation are becoming more mainstream and accessible to the general public. These technologies used to be out of reach to the average consumer, but tax incentives and improvements in technology have made them more obtainable than ever.

The key to obtaining a return on investment for any energy efficient product is to do it right the first time. New construction offers an enormous opportunity to "get it right" the first

time, using integrated design and all the appropriate technology options. Neither retrofit nor renovation can be expected to achieve comparable energy efficiency results (Adelaar, 2008). Renovation and retrofits are limited in how aggressive building-envelope improvements can be versus new construction where holistic integrated design can be implemented. Heating and cooling improvements show the greatest disparity in net energy efficiency gains relative to the baseline unit performance. Heating improvement can have a 95% energy usage reduction whereas renovation only obtains an 80% reduction, and retrofit only 60%. Thus, that gives us a 35% increase in net energy efficiency by simply changing the time in which the same methods and components are implemented (Adelaar, 2008).

For energy efficiency to be realized, improved technology and product selection are not the only solutions. There are a few things that must be addressed as barriers: information and education, incentives and financing, codes and standards, and third party involvement (McKinsey & Company, 2009). Each of these barriers can be overcome with careful planning and execution. Getting the end consumer educated on how to best utilize the technology is one of the simplest yet most effective methods to put the technology to work to achieve its intended benefit. How many homes in America have programmable thermostats but never get programmed because no one taught the homeowners how to use it as it is intended?

The International Energy Conservation Code (IECC) had a goal to improve the standard code home by 30% in efficiency by 2010. (Home Energy, 2011) The goal is to sequentially set the bar higher and higher each year to mandate energy efficiency via code compliance. The IECC measures code compliance by using the Home Energy Rating System (HERS). A HERS rating is the national standard for measuring energy efficiency of a home. The HERS standards are

maintained and developed by a not-for-profit association of rating providers called Residential Energy Services Network (RESNET). The rating is determined by dividing the projected energy consumption of the home by the projected energy consumption of a reference home and multiplying by 100 (Home Energy, 2011). A code home would have a HERS index of 100 where a net zero energy home (a home that annually produces as much or more energy than it uses by photovoltaic, wind or water, or solar hot water heating) would have an index of 0. HERS ratings are used to measure compliance with ENERGY STAR and NAHB's National Green Building Standard.

In order to calculate the energy consumption of a home, HERS rating software considers the areas and thermal envelope of the building which includes walls, windows, ceilings, floors, etc. The software also considers the heating, cooling and hot water systems along with the lighting and appliance energy usages. The energy loss due to air infiltration and duct leakage are also considered using a blower door test to establish metrics of actual performance (Home Energy, 2011). A blower door test basically seals the home and applies a negative pressure with a fan that tests the amount of air passing through it to the outside. Smoke is introduced into the duct work in order to determine where and how many connections in the air handling system are occurring. Air infiltration is measure by comparing how much air the fan is pulling out of the home once a negative pressure is established, or how much air is infiltrating through walls etc.

All in all, when considering energy efficiency in construction, lifecycle cost savings will be realized. Money, previously ear marked to be spent on energy or one time use items can be put back in our pockets. This money can be invested in more up front energy saving appliances

and building envelope products. It is a revolving door of investing in future savings or looking at lifecycle vs. initial costs of buildings.

Buildings consume 72% of the U.S. energy resources daily and account for 38% of all carbon dioxide emissions (Environmental Information Administration, 2008). Construction of buildings uses 40% of the available raw materials globally annually which equates to about 3 billion tons (Roodman, 1995). The EPA estimates that 136 million tons of building related construction and demolition debris is generated in the U.S. annually (Environmental Protection Agency, 1997).

Green Building is expected to have substantial growth in the residential, education, government, industrial, office, healthcare, hospitality, and retail sectors of construction. Besides residential construction, the top 3 sectors are office, education, and healthcare which accounted for more than 80% of the total non-residential green construction (McGraw-Hill, 2006). The question is: what is driving Green Building to gain such a large portion of the GDP and construction industry as a whole? Government initiatives coupled with heightened residential demand for green construction and improvements in sustainable materials is taking the Green Building movement to a heightened level of expectation by the general public rather than an alternative, which it was in its infancy.

2.6. Summary

This chapter has provided an overview to the literature and research relating to sustainability and Green Building. It has summarized the research previously done with students at the university level to determine levels of *interest* and *knowledge* of topics within

the Green Building movement. A summary of building techniques and product that are deemed to be green has also been given.

The results of this review of literature provide a confirmation of *interest* among the general population and potentially the student population that would demand an avenue for students to gain a formalized introduction to the sustainability and Green Building industries. None of the literature seems to address the determination of what should be taught and for whom the curriculum should be developed. Thus, the next chapter will provide a necessary background on qualitative inquiry as well as the methodologies and framework used in this study.

CHAPTER 3. FRAMEWORK AND METHODOLOGY

The purpose of this study was to determine the educational needs and desires of university students in regards to sustainability and Green Building. The study would be used to create a general elective course offered to all students across all disciplines and majors. Due to the nature of the study and outcomes desired, the qualitative research method was selected. This method will provide the most efficient data analysis to be completed to determine the current levels of *interest* and which topics that should be covered in the "greening your existing or future home" course.

This chapter outlines the methods that were used in the study, including survey facilitator software, access, sampling, data collection, and analysis procedures. The chapter concludes with an assessment of accuracy and triangulation of data relative to this study as mentioned in the review of literature.

3.1. Theoretical Framework

My perception of students at the university level is that they are looking for something to define their lives. Students come to the university setting to search out ideals and beliefs that will shape their careers and lifestyles long after completing their degrees. I agree with the research that was presented in the review of literature that states that the university setting is the perfect platform to teach sustainability and Green Building. My opinion is that the

concepts taught within sustainability and Green Building is far more applicable than just in the realms of engineering, architecture, and construction majors. I believe that students are genuinely *interested* in ways to be more sustainable in their lifestyles, but lack an outlet where they can be educated what a greener lifestyle is.

The project is to establish a baseline upon which a curriculum can be developed to teach students about Green Building and ways to incorporate sustainability into their lifestyles. The qualitative approach will provide data that can be analyzed to determine areas where sustainability education is working and areas where it can be improved. My methodology is to teach the concepts to a broader audience in order to better prepare them for sustainability's broad reaching effects, which they are bound to encounter after college is just a memory.

3.2. Methodology

Create an online survey to explore student's perceptions and *understanding* of Green Building and sustainability. The survey will consist of questions investigating their current *knowledge* and *interest* of various topics associated with Green Building practices. The survey questions were developed to enable the results to be compared and contrasted with prior studies discovered during the literature review process. New questions were developed to discover the *interest* level and educational disparities in regards to Green Building practices. These questions were developed to determine what the curriculum should include and how much time should be spent on each topic.

The need for a pilot study was evidenced very quickly as the survey questions were being developed. My research assistant took the questions home to his wife, who had no

previous education of sustainability and Green Building. She was instrumental in the phrasing of the questions to allow anyone who was not previously familiar with these topics to participate in the study.

I presented the pilot studies to family members and students in a few of my classes in the spring semester of 2010. These classes consisted of primarily freshman and sophomore students who were enrolled in Design Graphics courses. The first class was an introduction to engineering course that was required for Mechanical Engineering Technology, Manufacturing Engineering Technology, and Design Graphics Engineering Technology programs. The Design Graphics students were exposed to both mechanical engineering and architectural engineering curriculum, but had not had any formal education about sustainability and Green Building. The second class was for Design Graphics students only, learning basic CAD skills along with residential design theory and application. This group had been exposed to elementary concepts of sustainability and Green Building, but was by no means experts or familiar with the subjects. The third class was for senior level Design Graphics students learning 3D architectural CAD skills and theory related to commercial architecture. These students had been exposed to intermediate to advanced concepts of sustainability and Green Building. In fact, one of their projects in the class was to research and present to their peers a topic of their choice that dealt with sustainability or Green Building. The last group of students involved in the pilot study was senior students involved in a cap stone project studying sustainability and Green Building as part of their project entitled “Sustainability Through Size” for which I was the advisor. After meeting with the students to discover discrepancies, disparities and confusion found in the survey, an invitation email was sent to 24,052 students at Weber State University in Ogden, Utah, and 4,000 students at Purdue University in West Lafayette, Indiana.

The survey was administered to the general student body enrolled at Weber State University and Purdue University. The goal of the study was to get a good cross section of all majors or disciplines in order to validate the need to develop a general education course. The invitation to participate in the study was limited to 4,000 randomly selected students at Purdue University based on administrative restriction set by the graduate office. The instruction given to the graduate office at Purdue was to select an equal number of potential participants across all colleges and majors at the university. The entire student body enrolled in the fall semester of 2010 at Weber State University was invited to participate. This consisted of 24,052 students.

In order to solicit the maximum amount of respondents, a follow-up email was sent two weeks after the initial email as a reminder. The initial email was sent just before Thanksgiving break, timed to catch students with minimal homework load and get better participation rates. The follow up email was sent just after getting back from the break to catch students with renewed excitement for their academic pursuits. The e-mail was also timed strategically when students would be registering for the next semester of courses, with general elective courses fresh on their minds.

This methodology will allow a comparison of students located in two distinct geographic locations. The two locations represent different regions. The Midwest and West regions of the U.S. will be represented upon which broad analysis of current sustainability education in each region can be drawn.

The students were recruited via their school assigned email address. An invitation email was sent to them inviting them to participate in the study. A single email invitation sent to students university email through local list servers were used to solicit respondents using an

HTML link to the 3rd party software website. Qualtrics survey software was used to distribute, collect, and analyze data from Purdue Students. Survey Monkey software was used to distribute, collect, and analyze data from Weber State University students.

Instructions were provided to enable students to either click on the imbedded HTML link to the website of the software selected based on site location or copy and paste the link into their web browser. The only difference between the emails distributed to the students at Weber State University was the link to survey monkey. (HTTP://WWW.SURVEYMONKEY.COM/S/GREENBUILDINGINGENERALEDUCATION)

The invitation email is shown below that includes the mandated explanation of how long the survey is estimated to take as well as the requirement that participants be 18 years of age.

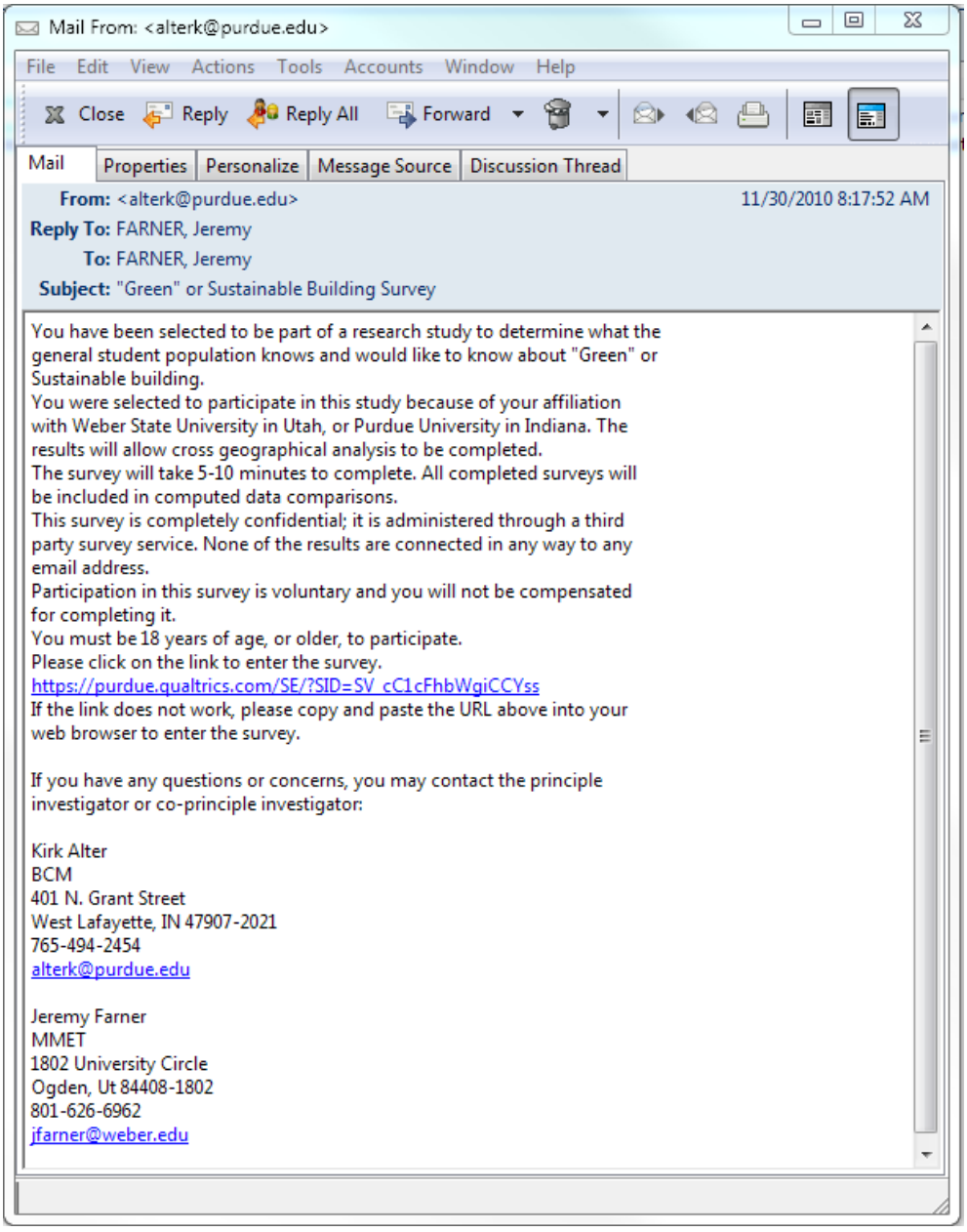


Figure 3.1. Purdue University Invitation Email to participate in study.

3.3. Study Environments

The research was conducted electronically at Purdue University, a land-grant university situated within West Lafayette, Indiana, which was one of the 25 largest universities in the U.S. at the time of the study. This research intensive University offers approximately 5,700 courses in more than 200 specializations, organized through 12 undergraduate colleges or schools and a Graduate School. Approximately 38,500 students were enrolled at the West Lafayette campus (34,000 are full time students); while 30,000 others pursued coursework at four regional campuses and ten statewide Technology locations.

Historically, the primary academic emphasis at Purdue University was agriculture, engineering, science, and technology. However, the four largest schools within the university (by student count) were engineering, liberal arts, technology and science, respectively, at the time of this study. Approximately 10 percent of the undergraduate population was composed of ethnic or racial minorities and approximately 42 percent were women. The University confers over 5000 Baccalaureate degrees, 1000 Master's degrees, and 400 Doctoral degrees each year. (Mukerjea, 2011) Purdue University had a rich history in engineering—being one of the primary aspects of its land-grant mission. Over the past 100 years, the various engineering programs at Purdue University have become nationally recognized. Several other schools and programs are also recognized nationally and internationally.

The research described in this report was conducted primarily with student's resident at the West Lafayette campus. I was a graduate student of Purdue University in the Department of Building Construction Management in which a proportional segment of the research occurred. One of the critical aspects of qualitative research credibility is access and immersion in the environment of the participants (Denzin & Lincoln, 2000).

The research was also conducted electronically at Weber State University; a state funded university situated within Ogden, Utah, WSU was ranked in Forbes magazine as being in the top 50 of America's Best Public Colleges at the time of the study. This Teaching University offered more than 200 undergraduate majors and 8 graduate degree programs, organized through 7 undergraduate and graduate colleges. Approximately 24,052 students were enrolled at the Ogden and Davis campus' (15,563 are full time students); while 8,489 others pursued coursework at 4 regional campuses part-time.

Historically, the primary academic emphases at Weber State University have been health professions, education, and technology. However, the four largest schools within the university (by student count) were engineering, liberal arts, technology, and science, respectively, at the time of this study. Approximately 8 percent of the undergraduate population was composed of ethnic or racial minorities and approximately 52 percent were women. The University conferred over 4,127 Baccalaureate and 114 Masters Degrees in the 2009-2010 school years.

The research described in this report was conducted primarily with students enrolled at the Ogden and Davis campuses. I was a faculty member of Weber State University in the Design Graphics Engineering Technology in which a proportional segment of the research occurred. One of the critical aspects of qualitative research credibility is access and immersion in the environment of the participants (Denzin & Lincoln, 2000). Conducting this study at my place of employment and graduate studies helped to meet this criterion.

3.3.1. Participant Population

The respondents for this study were solicited based upon their affiliation with their university. As explained earlier, it was necessary to get a large cross section of the student body to participate in the study, in order to determine overall *knowledge* and *knowledge* gaps associated with sustainability and Green Building education. The survey was an unpaid solicitation and therefore reported typical response rates. The 4,000 surveys sent at random through student issued email addresses across all colleges at Purdue University solicited a response rate of 10.5% with 419 respondents participating. The 24,052 surveys sent to all students' at Weber State University in the fall semester of 2010 returned a response rate of a 4.3% or 1,041 respondents participating. This is more than likely based on Purdue University primarily being known as a research institution and respondent survey fatigue is in play. It may also have to do with the fact that I was able to promote the survey within my own college and encourage participation. I had previously done a pilot study with several of my courses and students were aware the survey was coming. I don't believe this disproportionately skewed the data since, as can be seen below, only 12% of the respondents from Weber State that participated came from the College of Applied Science and Technology.

The comparison of the respondent's age and affiliation allows significant interpretation or analysis to be done. As shown below in figures 3.2 - 3.7, not only was there a good cross section of majors or colleges from which students are represented, but there is a good cross section of students from all classes represented. The data shows a small portion of the respondents being faculty or staff. This may be due to them working as staff on campus at the same time they are taking classes in pursuit of a degree. The average year in school that participants were in would fall between the sophomore and junior years. This is where I would

suggest the general elective be placed in the progression of coursework due to the maturity level that is needed to analyze and participate in discussions about the implications of sustainability and Green Building.

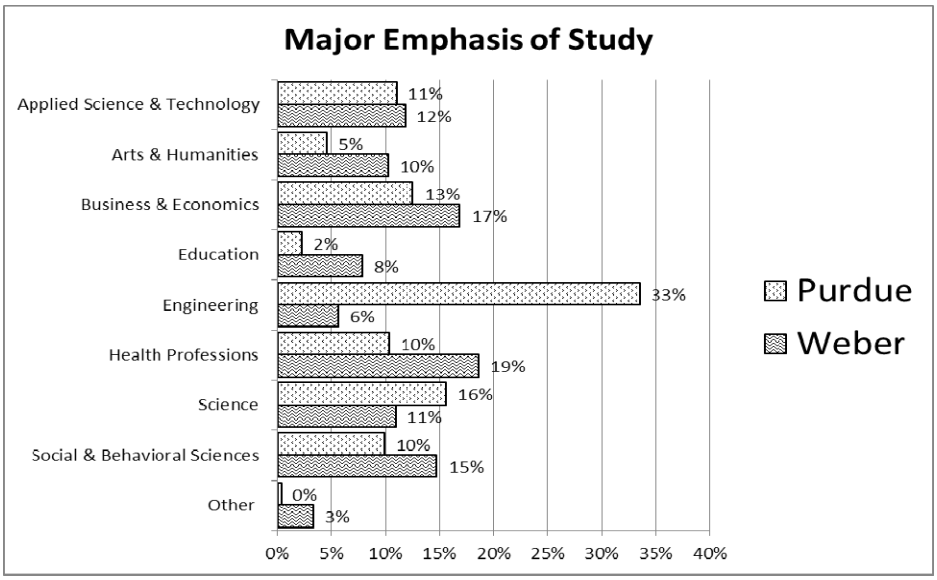


Figure 3.2 Majors of Study of Participants from both Universities

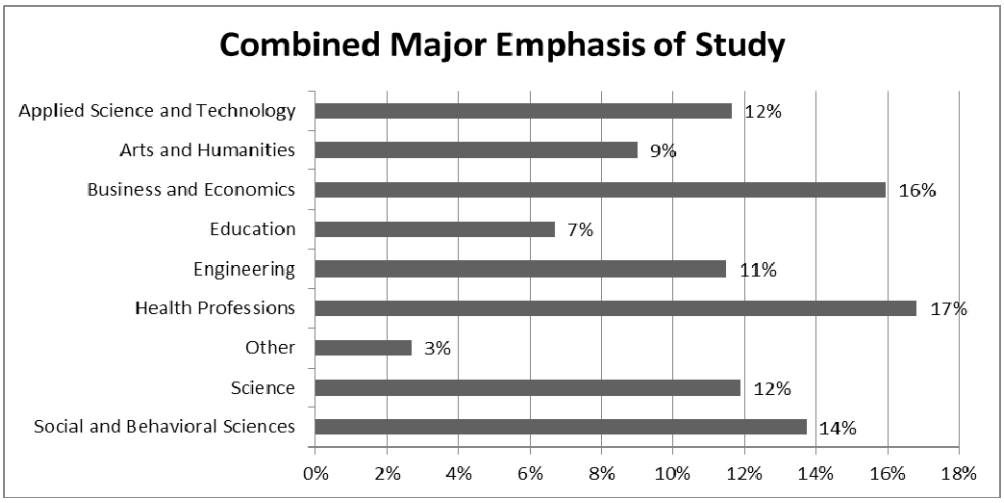


Figure 3.3 Combined Major Emphasis of Study

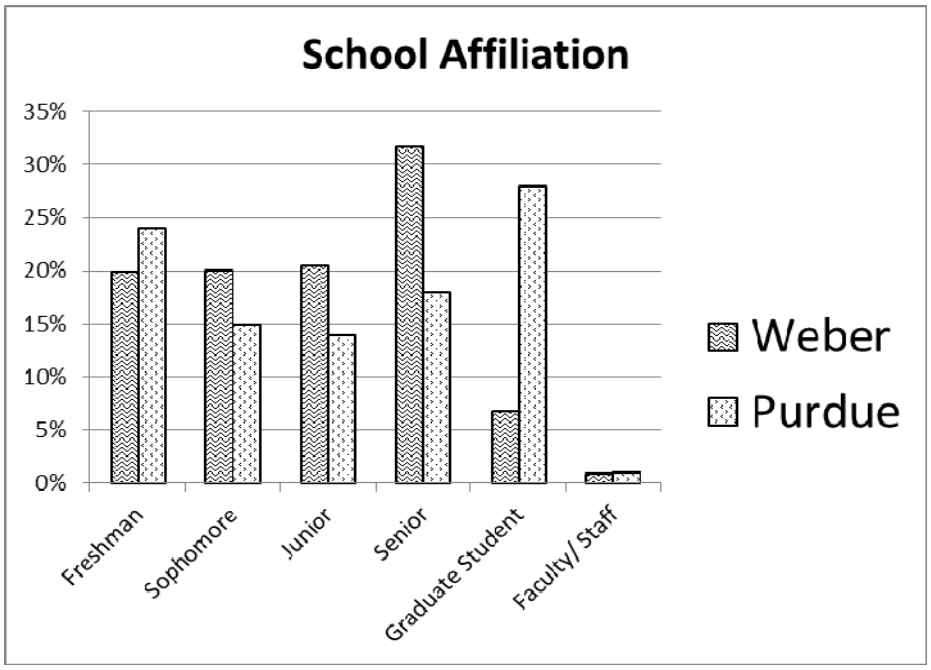


Figure 3.4 School affiliation based on year of study

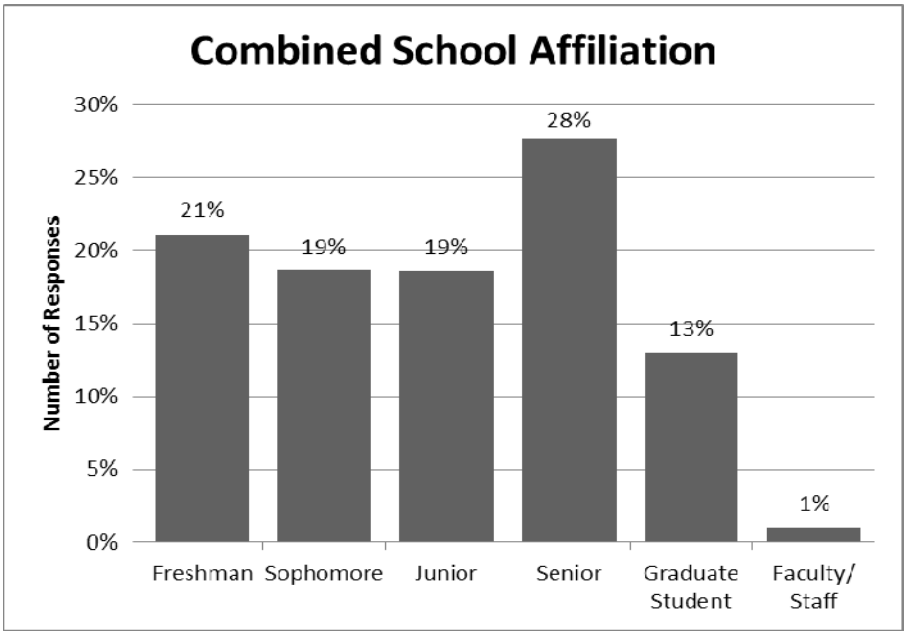


Figure 3.5 Combined School affiliation based on year of study

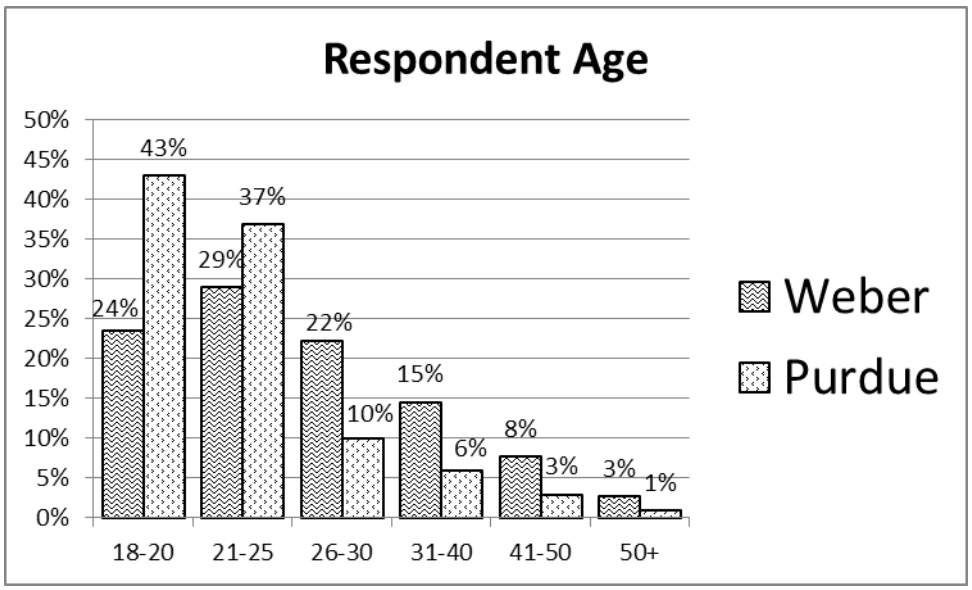


Figure 3.6 Respondent Age by Category and School

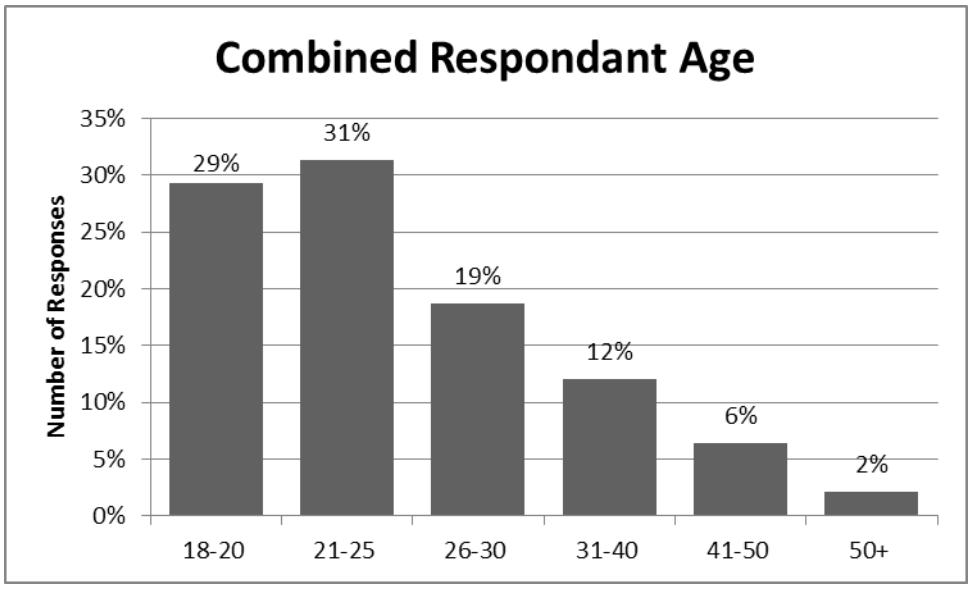


Figure 3.7 Combined Respondent Age by Category

My observation that the sustainability and Green Building general course be placed between the sophomore and junior years will be further explained later in the analysis as *interest* and ROI expected payback times are discussed. Another element that points to this observation is the comparison of words chosen by respondents to describe Green Building. These words will be visually represented based upon prevalence in a later figure.

3.4. Permissions

This section outlines the permissions that were sought in order to solicit respondents through a survey at the university level. Permissions included human subjects' approval at both Purdue and Weber State universities. The review board required written explanations of the study and the use of the data upon completion. They also required that all participants be at least 18 years of age. This was verified through a pre-screening question that would not allow them to proceed with the survey until they had answered in the affirmative that they were of age. It was of importance to the board that no compensation (monetary or educational) was involved, and that participation in the study did not involve risk to the students beyond that faced in daily life. Appendix C and D provide the Research Consent Form approved by the Purdue and Weber State University Human Subjects Committees as well as application.

3.5. Unit of Analysis

From the outset, it was important for me to determine what the unit of analysis was going to be and how to design my qualitative and quantitative study to meet the proper outcomes. It was important for me to "decide what you want to be able to say something about

at the end of the study" (Patton, 2002, p. 229). The primary question posed in this research was; "What are students' current *understanding* and perceptions of Sustainability and Green Building, and should a general elective course be developed to address the *knowledge* gaps and misconceptions discovered?" The follow up would be to establish; "what should be included in the class and the weight that should be placed on each topic identified in the study."

The secondary concern for me was to determine which approach to sampling was the most effective. Patton (2002) establishes that purposeful sampling is one of the defining marks found in qualitative studies.

The tertiary concern was establishing a legitimate cross section of students across all disciplines and colleges. It was determined to validate the study it needed to have a minimum of 1,000 respondents with somewhat equal distribution across all disciplines and colleges. Although the data collected at Purdue was heavily weighted with respondents from the college of Engineering as seen in figure 3.8, the diversity of majors reported by respondents within this study proved to offset the disproportionate response compared to other colleges. As seen below in figure 3.9 when combined with the data collected at Weber State University this did not prove to be detrimental to obtaining a good cross section of respondents.

Given these criteria for establishing data that was sufficient to analyze for themes and essenses, the respondent numbers and rate of response are satisfactory. The quality of responses and inquiries via email about the likelihood of a course being created in the near future exhibits the *interest* level of students at both institutions. It substantiates my theory that students across all disciplines and colleges are *interested* in sustainability and Green Building is justified.

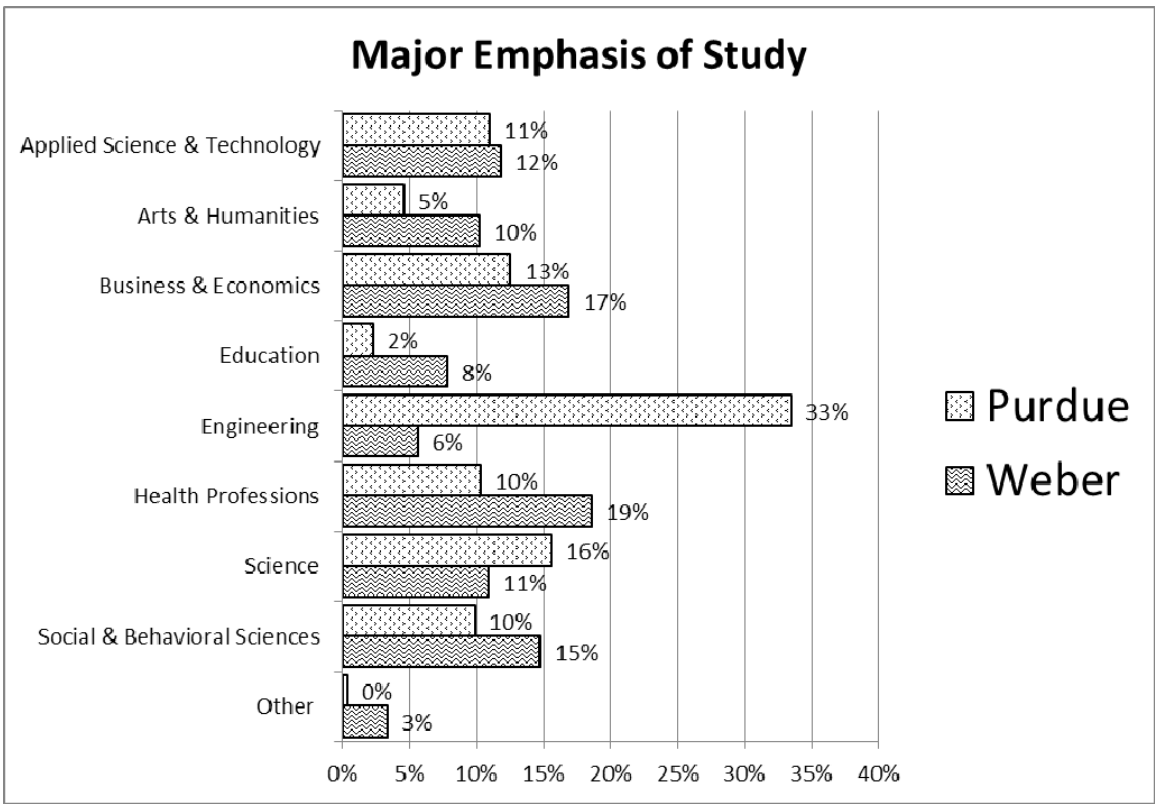


Figure 3.8 Respondent Major Emphasis of Study or College

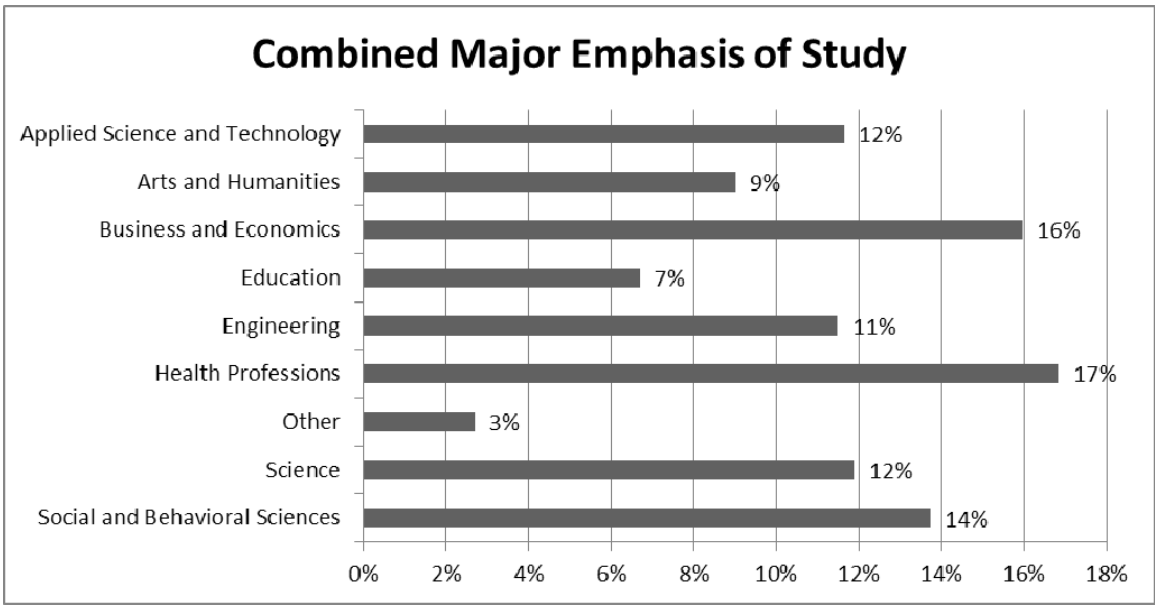


Figure 3.9 Combined Respondent Major Emphasis of Study or College

3.6. Data Collection

Researchers agree that one of the best data collection techniques is for self-reflection to occur throughout the process (Creswell, 1998; Moustakas, 1994; Seidman, 1998; Van Manen, 1990). Although they suggest the long interview as the best method of obtaining data, a survey that promoted self-reflection (such as mine) would be sufficient to provide relevant data.

The questions were written to enable correlations between responses be drawn to prior questions written in a different format. An example of this was found when comparing Question # 13 to Question # 15. Question 13 asked participant to "Rank YOUR personal motivation to go Green", while Question 15 asked "If you were considering building or buying a home, which of the following would most likely motivate you to incorporate Green Building principles into your own house?"

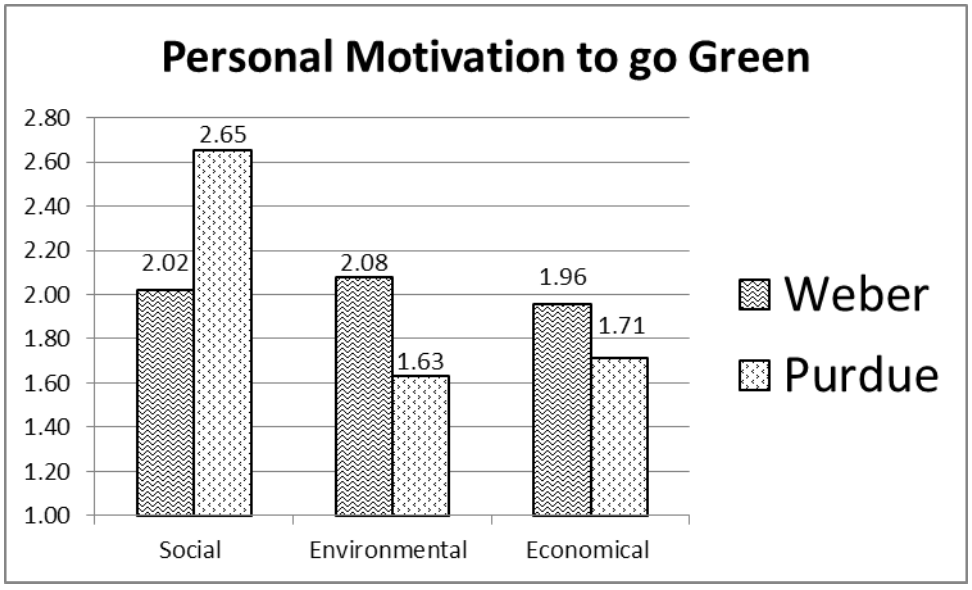


Figure 3.10 Personal Motivation to go Green School Comparison

It is interesting to compare the responses to what could be deemed the same question worded differently. Question #13 asked students to rank their motivations from 1-3 with 1 being the most important motivation and 3 being the least important motivator to them personally. The responses were assigned a rating average. Weber State University student placed more emphasis on the *economic* motivation, returning an average of 1.96. *Social* motivations with the example given of "Peer Influence or Popularity of Green" received an average of 2.02. Although it is not statistically relevant with the data from Weber State, the *environmental* motivation with the example of "Save World" given elicited an average of 2.08. Thus, essentially students at Weber State University rank their personal motivation to go green in this order: e*conomic*, *social*, and then *environmental*. Whereas if you apply the same concept to the data at Purdue university students rank their personal motivation to go green in this order: e*nvironmental* (1.63), *economical* (1.71), and then *social* (2.65). Many conclusions could be drawn from the comparison of these two schools including:

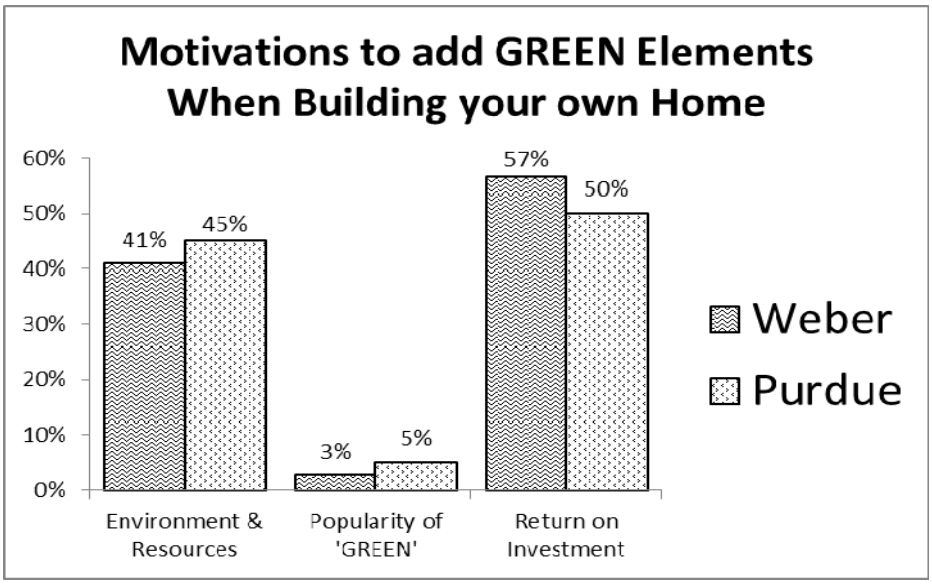


Figure 3.11 Motivations for Green Elements when Building your Home Comparison

- Purdue students are more *environmentally* conscious than students at Weber State University.
- There is more statistical relevance to the data collected at Purdue University due to the separation of personal motivation rankings.
- *Economical* motivations are not exclusive from secondary motivations such as *environmental* and *social* influence from peers or popularity of the green movement.
- University students, combining both schools, rank their most influential personal motivations to go green in their built environments as *economical* or “Save Money”.
- University students also rank their secondary influential personal motivation to go green as environment concern or “Save World”.
- University students do not associate *social* or “Peer influence or Popularity of Green” as being influential in their personal motivation to go green in their built environment.

If you tie *environmental* (Save World) from Question #13 to concern for the environment & natural resources in Question #15, *economical* (Save Money) to getting a return on investment, *social* (Peer influence or popularity of green) to concern for environment & resources, you can compare the response discrepancies. The discrepancies allow a comparison to be made between students responses posed in two different scenarios. The first is a theoretical situation where nothing is lost or gained, whereas the second situation asks students to determine what they are motivated by when money is involved. Table 3.1 shows a comparison of the response options given in questions #13 and #15.

Table 3.1

Response Discrepancies between Questions 13 and 15

Question 13	Question 15
Environmental	Concern for Environment & Resources
Economical	Getting a Return On Investment
Social	Going with the flow-popularity of 'Green'

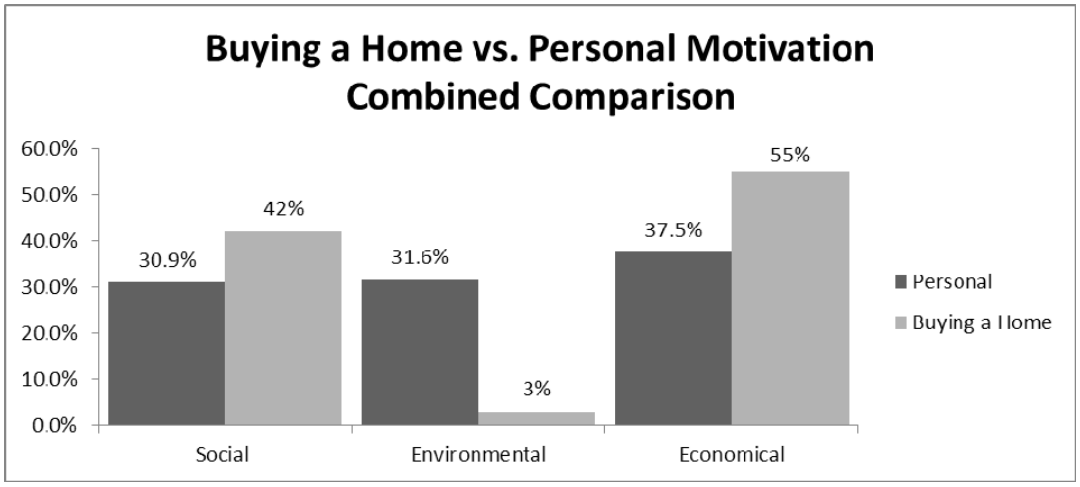


Figure 3.12 Buying a Home vs. Personal Motivation Combined Comparison

According to the comparison of the resonant data collected from Questions 13 and 15, themes can be extracted about students ranking of motivations to go green when they are personally affected.

- University students' number one motivating factor when buying a green home or making green improvements is *economical* or when they will start to see a return on their investment.
- Manufacturers and homebuilders would be wise to market their green products with getting a return on investment as their primary emphasis with an *environmental* concern as their secondary approach.

- There is little evidence that promotes there is really a “fad” within the green movement, but that motivation to go green stems from *economic* and *environmental* concerns.
- Although university students rate *economical* return on investment as their primary motivator in going green, *environmental* aspects cannot be ignored and should be factored in to decisions about implement green features in a home.
- When buying a home, or when money is involved, environmental motivations or concerns are not a significant factor.

- Economic considerations are the single most important motivator for college students when deciding to go green, especially in deciding what shade of green to go.

- The secondary concern or motivation for students to go green is how their actions are perceived by their peers. If it is marketed well that a particular item or technology is green and popular it is more likely to sell.
- Environmental concern is socially acceptable and therefore has a higher rating when theoretically put up against economic and social motivations, whereas when money is considered has little relevance to decisions to implement green features.

It is important to note here that the questions were worded differently and therefore subjective interpretation could have skewed the data slightly. Another potential discrepency could be argued where students were able to rank from 1-3 their motivations in Question #13 and only allowed to select their highest motivating factor in Question #15.

3.7. Data Analysis

The analysis of data collected was based on Giorgi's (1985, 1997) recommendations. According to Giorgi, there are three major steps to analyze data correctly; bracketing, intuiting, and describing. Each of these steps requires the manipulation of data in various ways to extract the data intended.

The initial step was to bracket or cross tabulate questions to elicit themes and essences based upon responses. An example is comparing age or major to *familiarity* or *interest* in sustainability and Green Building. The goal is to set aside one's beliefs so the data can be analyzed without preconceptions or presupposition that could alter its outcome. Following the collection of data from each source or university via third party survey software, I analyzed the data using the tools available in each survey software package. Other software tools such as Microsoft Excel, PowerPoint, and Word were also used in the dissemination of data to create charts, graphs and presentation materials.

The second phase of data analysis is intuiting or to develop meaningful units based upon the themes found in the initial bracketing phase. This was done by identifying emerging themes and creating graphs or comparison charts using the aforementioned software tools. At this point, it was necessary to combine meaningful units to see if they had any similarities or differences that could potentially be significant to the study.

The final phase, according to Giorgi, is describing. The purpose is to create a structural description of the meaningful units established in the second phase. This in essence comprises chapter 5 of this paper. It is the narrative description of meaningful units or outcomes and themes that were identified through the analysis of data comparisons etc. (Giorgi, 1997).

3.8. Credibility

Quantitative research depends on the validity and reliability of instruments used for measurement as well as the methodology employed. Patton (2002) describes credibility as being the most important aspect of quantitative research. Merriam (1998) agrees that quantitative terms can be applied to qualitative studies. Both believe that credibility is reliant on the credibility of the researcher and the philosophical beliefs on the value of qualitative inquiry on the part of the researcher.

Data from various types of sources and questions help to reveal different aspects of "empirical reality" in qualitative studies (Denzin, 2000). Triangulation of sources and methodologies is not just to confirm the data, but also allow examination and exposition of differences as well. (Patton, 2002 He goes on to explain "Finding such inconsistencies ought not be viewed as weakening the credibility of results, but rather as offering opportunities for deeper insight into the relationship between inquiry approach and the phenomenon under study"(p. 248). This study triangulated the data results by using professors from both universities to develop the questions as well as gaining student perspective throughout the entire process from my research assistant, as well as question types and different delivery survey software packages at each school.

This chapter has been devoted to outlining the methodology implemented in this study. Almost all of the decisions made were based on the work of respected researchers and recommendations they have made, both verbally and written. I believe this and prior chapters have indicated the belief in such approach methodologies. The following two sections will address just those issues researcher credibility or triangulation of data sources.

3.8.1. Credibility of the Researcher

Due to my prior experience with developing new curriculum at the university level, as well as my association with engineering, architecture, and construction students, I believe I had the required perception and credibility in regards to this study. Eisner (1979) explained that connoisseurship (perception) can only come from appropriate "sensibilities related to the domain of interest" (p. 231). Although *interest* can be easily expressed in year of experience or prior publications, my opinions and *knowledge* have been accumulated over a broad exposure in industry, personal experience, personal inquiry due to curiosity, and academia to the world of sustainability and Green Building. I have been involved with sustainability and Green Building for the past 10 years as a participant in home building as a laborer, designer, and management professional. My professional and personal involvement with Green Building also includes teaching architecture, engineering, and construction management students at my current place of employment for the past 3 years. Each time I teach students about sustainability and Green Building I am reminded how little *knowledge* already exists, compared to the *interest* level of students.

As the first chapter explains, personal experiences bred my curiosity about this subject to learn more about this topic and eventually led me to the questions presented in this study. My approach to chapter 2 was to give a comprehensive review of what currently exists within the sustainability and Green Building movement in order to analyze what students already knew and had *interest* in learning more about. While it is up to the reader to determine my credibility, it is hoped that my experience both in industry and academia combined with the literature review will be sufficient.

3.8.2. Triangulation

The validity of qualitative research is established by triangulation of data (Patton, 2002). Triangulation is used to cross examine or validate the results of a study by indicating that more than two methods were used to double or triple. Data validity can also be established via the richness of descriptions provided by participants (cross validation of data as explained above), the setting, and the researcher (Peskin, 1993). This study aimed to provide multiple data sources from varying geographic locations in and outside of the U.S. in order to determine the *knowledge* and *interest* levels of students at the university level in regards to sustainability and Green Building. These data sources can be triangulated to compare and contrast the data in order to establish outcomes of the study. One example of this would be that the larger the sample size from different representative populations throughout the U.S. would triangulate the findings of student perception in general.

Denzin (2000) described a method where four different ways triangulation can occur, namely: data, investigator, theory and methodology. First, he suggests that a variety of data sources be utilized. This was accomplished by using an existing study as the spring board to complete studies at two distinctly geographically separated universities. Purdue is recognized for its engineering programs and had a graduate college that promoted research. Weber State University is recognized as a teaching institution. The universities are not only geographically separated, but also methodologically different to allow triangulation of the data obtained.

Secondly, he suggests investigator triangulation. This essentially is using multiple researchers to set up the data collection. This was done with a student at Weber State University as my research assistant, and collaborating with multiple professors at Purdue

University. The research assistant and professors collaborated in the creation of the questions.

Thirdly, theory triangulation occurred in the collaboration effort as well as all questions were thoroughly analyzed to determine how students may respond differently, based upon the way questions were worded. Initially there were many more questions, but after discussing the main goals of the survey were, some were either eliminated or combined into the questions that were included.

Lastly, for methodological triangulation, a variety of methods were used. This was accomplished by having multiple types of questions as part of the survey. The survey included Likert scale questions as well as multiple choice and subjective fill-in-the-blank questions. This study attempted to utilize all of the above mentioned methods to attempt to add credibility and trustworthiness to the data collected.

3.9. Summary

This chapter has been an overview of the framework and methodology used in the study. It has outlined the specific methods established as my framework for the study. The next chapter will offer an in-depth look into the findings of the study. In that chapter, the actual data and analysis thereof will be explored in detail. The opinions, perceptions, *knowledge* and *knowledge* gaps will be uncovered to allow analysis and essences to be developed as to what should be included in a sustainability and Green Building course. This question will also be answered: “Is there more broad *interest*, that a general elective course be developed, other than in the fields of engineering, architecture, and construction?”

CHAPTER 4. PRESENTATION OF DATA

As described in previous chapters, the purpose of this study was to determine if a general elective course open to all majors and disciplines should be developed. For this to be determined, an inquiry of *interest* levels in such a course, proportionate across all disciplines and majors, was in order. The secondary research would find out what existing *knowledge* students had, and where *knowledge* gaps existed in order to determine what should be taught in such a course.

This chapter examines the data obtained from each school, starting with Purdue University and followed by Weber State University. The chapter following will attempt to draw parallels between both schools and all respondents.

4.1. Schedule of Data Collection

The collection and analysis of results took place from November 2010 to February of 2011. The analysis and interpretation thereof will assist in establishing a baseline of data to be used in the development of curricula designed to educate students at the university level on sustainability and Green Building. The data could also be used to establish the *interest* level and need to develop the curricula to be taught as a general elective course to be offered to students from all disciplines and colleges across the university.

4.2. Data from Purdue University Survey

The first question was the consent question to determine whether students were 18 years of age and to make sure they knew that they were not being compensated for their participation as mandated by the Human Subjects Committee. The first statistically significant question posed was to obtain background and demographic data which was Question 2. The question was "What is your affiliation with your school?" This information could be useful when cross tabulation was done with age, *interest*, *knowledge* and motivations to go green. All classes from freshman to senior are almost equally proportioned in the study. The faculty and staff who were asked to participate had to have been enrolled in at least one class to be solicited to participate. It is not surprising that the highest response rate was from graduate students. They are sympathetic to researchers who are soliciting respondents to an unpaid survey because they are more than likely in the same position. If one were to take an average of the class of students who participated, it would fall between their sophomore and junior years.

Table 4.1.
Purdue Survey Question #2

What is your Affiliation with your School?

Answer	Percentage
Freshman	24%
Sophomore	15%
Junior	14%
Senior	18%
Graduate Student	28%
Faculty/ Staff	1%

The third question was to determine age. This would be useful in determining if there were any *interest* or *knowledge* discrepancies between age groups that could be meaningful in determining the ideal time of the proposed course in the students' academic progression, or the

class level at which to teach it. It is of *interest* that 43% of the respondents from Purdue are under the age of 20.

Table 4.2.
Purdue Survey Question #3

What is your Age?	
Answer	Percentage
18-20	43%
21-25	37%
26-30	10%
31-40	6%
41-50	3%
50+	1%

This would mean that their experiences with large purchasing decisions are somewhat limited. In other words, they are below the typical average age at which a home is purchased or other significant purchases are made that may have involved *knowledge* about or experience with sustainability and Green Building. The maturity of the students perceptions to lifecyle cost analysis could be called into question whether they appreciate the *economic* and *environmental* motivations discussed. One question that was not adressed at this point that may have been of interest would have been to inquire about the currently living situation they were in. A coorelation between those who rent vs. those who own or lease a home may have shed some interesting light on how *knowledge* and *interest* relate to different living situations.

This demographic question can be used to cross-tabulate responses based on major emphasis of study with *interest*, *knowledge*, prior experience, and motivations to go green. It is of note that the highest percentage of respondents are found within the college of engineering. This validates the afformentioned emphasis of producing engineering students at Purdue

University. The table above also shows that a sufficient cross section of students participated in the study. There are only two colleges that did not have adequate participation, but as stated above when compiled with the data from Weber State University these were brought into proper statistical balance from which to draw conclusions from.

Table 4.3.

Purdue Survey Question #4

What is your Major Emphasis of Study?

Answer	Percentage
Applied Science and Technology	11%
Arts and Humanities	5%
Education	2%
Engineering	33%
Health Professions	10%
Science	16%
Social and Behavioral Sciences	10%
Other Please Specify	0%

The fifth question was designed to determine what the difference in *knowledge* or *understanding* would be between the main two terms used in this study. As seen below, sustainability seems to be better understood than Green Building. If the likert scale were to be applied to the possible answer selections below, a statistical analysis could be executed. The number 1 was associated with “Not at all familiar”, and the number 4 with “Very familiar”. The number of responses per category were then mulitplied by their appropriate number and divide by the total number of respondents. As seen by the mathmatical equation below, the mean or average scale could be discovered.

r= respondents

$$Mean = \frac{(r_1 * 1 + r_2 * 2 + r_3 * 3 + r_4 * 4)}{Total\ responses}$$

Table 4.4.

Purdue Survey Question #5

How would you rate your *knowledge*/ *understanding* of these terms?

Terms	Mean*	Variance	Standard Deviation
Green Building	2.75	.57	.75
Sustainability	2.98	.56	.75

*Not at all Familiar (1)
*Unfamiliar (2)
*Familiar (3)
*Very Familiar (4)

As seen in the tables above, the *familiarity* of the term Green Building has a mean of 2.75 or somewhat familiar but not confident enough to say familiar. The term sustainability received a mean of 2.98 or statistically familiar. This brings up the question: what, specifically, are students familiar with? Thus the next question was posed. This was not meant to be an exhaustive list, but a list of the major topics found within the Green Building and sustainability sectors.

As seen in Table 4.5, using the likert scale applying a 4 to High and 1 to None, a mean could be derived. The higher the number, the more familiar students were with a particular topic. NAHB Certified Green Built Homes was the lowest rated having a low to medium level of *familiarity*. Wind Power seems to have the least level of *familiarity* with Purdue students with solar power falling right on the medium familiary rating. Water conservation, appliance efficiency, hydro power and lighting efficiency all fall near the medium *familiarity* line. This data could be used to establish the areas that students already *know* and which areas could be taught in greater detail. This chart could be used to stage when and how long each topic is discussed or discovered in the class environment.

Table 4.5.

Purdue Survey Question #6

Please indicate your *Familiarity* with and *Interest* in learning about the following:

Terms	*Familiarity* Mean*	*Interest* Mean*	Difference
NAHB Certified Green Built Homes	1.76	2.66	-0.90
LEED for Homes	1.86	2.63	-0.77
Glazing (Window) Efficiency	2.28	2.74	-0.46
Solar Hot Water Heating	2.59	3.00	-0.41
Passive Solar Heating/ Cooling	2.52	2.93	-0.41
Sustainable or Renewable Construction Materials	2.65	3.04	-0.39
Geothermal Heating/ Cooling	2.58	2.89	-0.31
Insulation Ratings	2.45	2.75	-0.30
Recycled/ Reused Building Products	2.75	3.04	-0.29
Hydro Power	2.83	3.11	-0.28
Indoor Air Quality	2.66	2.93	-0.27
Lighting Efficiency	2.82	3.05	-0.23
Solar Power (Electricity Generation)	3.00	3.22	-0.22
Water Conservation	3.01	3.22	-0.21
Appliance Efficiency	2.83	2.97	-0.14
Wind Power	3.08	3.21	-0.13
Average of all Means	2.60	2.96	-.36

*High (4)
*Medium (3)
*Low (2)
*None (1)

According to this data, Purdue students are low to medium familiar with LEED for homes and NAHB Certified Green Built Homes, but have a high level of *interest* in learning more about these topics. These topics produce the greatest disparity or gap between *knowledge* and *interest* suggesting that this should be the topics that are discussed in the greatest detail. There could also be a coorelation drawn that the LEED program is more well *known* than the NAHB Certified Green Built program among Purdue students.

There is a much higher *interest* mean than *familiarity* which suggests that students are *interested* in learning about these topics. The average of all topics results in a 2.96 mean for intersest and a 2.60 for *knowledge*. We will further compare the *knowledge* vs. *interest* in section 3 of this chapter. The higher the difference between *knowledge* and *interest* suggests that those topics should be covered in greater detail and have more emphasis placed upon them. Glazing (Window) efficiency, solar hot water heating, and passive solar heating/ cooling are the topics with the highest differential between *knowledge* and *interest*. This suggests that student have a medium *interest* in these items but do not have as much *knowledge* in these topics. This would also suggest that wind power is successfully being taught to meet the *interest* needs of the students. Where students are being exposed to these topics is discovered in the next question.

Table 4.6.

Purdue Survey Question #7

In what fields have you had previous formal education where sustainability was addressed? (Select all that apply)

Answer	Percentage
Geography	13%
Biology	31%
Environmental Science	30%
Economics	22%
Design	18%
Construction	14%
None	34%

The table above shows where students have had previous formal education where sustainability was addressed. Respondents report that 61% have had exposure to sustainability curricula within the *environmental* realm which includes Biology and Environmental Science courses. It is also interesting that 34% of respondents have had no exposure to formal curricula

on sustainability. Only 22% of students reported having formal education about sustainability in economics, but still find this to be their highest rated motivating factor as established earlier in this paper. The categories chosen above are the natural locations where sustainability curriculum could be addressed quite easily without changing content in the courses a great deal. Sustainability and Green Building affect each of these areas quite heavily and as shown in the literature review are projected to play an increasing role in the future. My theory is that sustainability and Green Building will increasingly become a part of the content taught in these courses due to current event discussions that surround them.

Table 4.7.

Purdue Survey Question #8

Have you done any of the following? (Select all that apply)

Answer	Percentage
Researched, Designed or Built Green Structures/ Technologies Professionally	11%
Political Action such as Writing Letters to Senators, Protests, Campaigning, Boycotts, Membership in Greenpeace (or other) etc.	12%
Used Alternative Energy Sources (Solar, Wind, Hydro)	22%
Educating Yourself or Trained others about Green Building/ Sustainability Practices	32%
Changing Shopping Habits to Support Green Businesses	35%
Participated in Nature Conservation (Planting Trees, Trash Cleanup, etc.)	52%
Started Energy-Saving Habits	67%
Used Alternate Transportation Methods (Mass Transit, Bike)	73%
Recycling, Reducing Waste, Reuse, etc.	95%

Political action is not on the minds of students, whereas recycling, reducing waste, reusing materials is. Analysis shows that 73% of students surveyed are using alternate transportation methods and 67% of those are using energy saving habits. Only 11% of students have been involved with sustainability or Green Building research professionally or

academically, but 32% have taken the initiative to educate themselves or train others about sustainability or Green Building practices. Recycling, reducing waste and reusing items is nearing 100% with 95% of the student population taking part in at least one of those activities.

The next question addresses *interest* levels in taking a course about ways to "Green" an existing or future home. An almost perfect bell curve was created, proving that there is a moderate *interest* in taking such a course. This could be sufficient to prove that there is enough demand to create a general elective course on greening a home, while using the *interest* means from Question 6 above to determine the order and depth of the content. It is of note that 65% of respondents have moderate to extreme *interest* in taking such a course. This could be correlated with the high level of *interest* in home certifications that deal with all of the topics surveyed that fall within the realm of sustainability and Green Building. Only 11% of students profess to having no *interest* in learning about ways to green their homes. A comparison of age, affiliation, and *interest* in the course will be examined in Section 3 of this chapter. There is a high level of variance on this question that indicates that this question must be verified with an additional question that is worded slightly different.

Table 4.8.

Purdue Survey Question #9

What would be your *interest* level in taking a course about ways to "Green" your existing or future home?

Levels of *Interest*	Mean*	Variance	Standard Deviation
*No *interest* (1)	3.01	1.44	1.20
*Slight *Interest* (2)			
*Moderate *Interest* (3)			
*High *Interest* (4)			
*Extreme *Interest* (4)			

Table 4.9.

Purdue Survey Question #10

How likely would you be to take a course about the following "Green Building" topics, offered as a general elective and fulfilling a breadth requirement?

Class Description	Mean*	Variance	Standard Deviation
A Class about Steps to Greening your Home	2.53	.85	.92
Environmental Appreciation	2.31	.84	.92
Environmental Issues & Economic Policy	2.45	.85	.92

*Very Un-Likely (1)
*Unlikely (2)
*Likely (3)
*Very Likely (4)

The next question was a follow up question to determine the type of approach to Green Building to which students would be most receptive. This could be compared to their personal motivations falling into the *environmental*, *economical*, or *social* categories that were established earlier in this paper as being the three most prevelant motivational factor behind the sustainability and Green Building movements. This question reveals that students are more *interested* in taking a class that addresses solutions to *economic* problems such as efficiency and logical steps that they can take to green their home than theory based courses on *environmental* appreciation and *economic* policy. If the Likert scale were applied to this question a mean of 2.53 for the greening your home class is calculated, 2.31 for *environmental* appreciation, and 2.45 for *environmental* issues & *economic* policy.

Of the respondents reporting their attitudes towards Green Building, 74% feel it is a good thing and 10% are passionate advocates. Even if level of *interest* and the other questions posed to students are not sufficient to determine that a general elective course should be developed for all students in all majors, this should tip the scales of establishing need for such a

course. If 84% feel that it is a good thing or passionately advocate it, institutions should be providing education about what the movement really is and how they can participate.

Table 4.10.

Purdue Survey Question #11

What is your Opinion of Green Building in general?

Opinion	Mean*	Variance	Standard Deviation
*I think it is a waste of time and effort (1) *It doesn't bother me (2) *I think it's OK for others to do it (3) *I think it's a good thing (4) *I'm a passionate advocate (5)	3.83	.61	.78

The next question allowed students to write up to 4 keywords (not a sentence) conveying their personal *understanding* of "green" building or sustainability. The example was given "Peanut Butter: Creamy/ Sandwich/ Brown/ Sweet. The responses were analyzed to establish redundancies. A "wordle" was created to help visualize when a particular word was used to convey their personal *understanding* of Green Building. Wordles generate "word clouds" from text that you provide. The clouds give greater prominence to words that appear more frequently in the source text. Clearly the most common positive terms used were efficient, environment, and future. There were some negative connotative terms that were prevalent as well such as expensive. The negative terms were not nearly as prevalent as the positive connotative terms. It should be noted that some stemming was done to the raw responses to group similar words such as efficient and efficiency. Environmentally and environment were also combined. This is a unique way to quickly visualize how students feel about Green Building or Sustainability in general.



Figure 4.1 Purdue wordle from open opinion question (type 4 words)

Table 4.11.

Purdue Survey Question #13

Rank YOUR Personal Motivation to be more "Green"?
(Order YOUR preference from 1-3)

Motivation	Mean	Variance	Standard Deviation
Social (Peer Influence or Popularity of Green)	2.65	.34	.58
Environmental (Save World)	1.63	.55	.74
Economical (Save Money)	1.71	.48	.69

Questions 13 and 14 should be compared as to show the difference between what students personal motivations are to go green vs. what they percieve the public's motivations are. Students' responses using the Likert scale of analysis show that enviromental concerns are their foremost motivation to be more green. *Economic* motivations are second with *social* motivations being substantially further back in their personal motivations. Getting a return on investment for their green efforts is foremost in student's minds. As shown on the Wordle above, there is a perception that greening a home is expensive. This is yet another areaof study that could be addressed in the course.

Table 4.12.

Purdue Survey Question #14

Rank what you perceive motivates SOCIETY to be more "Green"?
(Order SOCIETIES preference from 1-3)

Motivation	Mean	Variance	Standard Deviation
Social (Peer Influence or Popularity of Green)	1.89	.56	.75
Environmental (Save World)	2.47	.55	.74
Economical (Save Money)	1.64	.53	.73

The comparison between these two questions reveals that students perceive *economical* motivation to be the highest motivator, but *social* pressure to be a close second. *Environmental* concern is rated substantially higher suggestion as students percieve society is not motivated to be more green in order to save the world. It would be interesting to determine exactly why students feel this way, but that was beyond the scope of this research project. Students feel that society is looking to save money foremost and are motivated to do so because of societal pressure on popularity. Again this data forced a ranking of the motivations and did not allow cross motivations to be evaluated. "When the wallet hits the register", the primary motivating factor is truly exposed. 50% of respondents were monitairily or econmically motivated, whereas only 5% were willing to put their money where their mouth was, previously stating they were socially motivated.

Table 4.13.

Purdue Survey Question #15

If you were considering building or buying a home, which of the following would most likely motivate you to incorporate Green Building principles into your own house?

Motivation	Percentage
Concern for the Environment & Natural Resources	45%
Going with the flow- Popularity of "Green"	5%
Getting a Return on Investment	50%

The application of this data could be argued due to the wording chosen in the question and that it did not follow the Likert scale as the two questions previously had done. This was done for triangulation purposes as explained above. Comparison of the last three questions should thus be done cautiously. *Economic* motivation was selected as being the greatest motivator to go green in all of the cases. This falls in line with the study previously mentioned in Chapter 2, which focused on review of the literature. The study done at University of Plymouth in the UK had similar outcomes. (Fumiyo, 2007)

Table 4.14.

Purdue Survey Question #16

What are you prepared to do in your personal lifestyle in regards to "Green Building" and Sustainability? (Select all that you would be willing to do)

Answer	Percentage
Consumer Change (Buy more Green Building Products i.e. Flooring, etc.)	68%
Recycling	94%
Energy and/ or Water Efficient Appliances	83%
Education (Learn and be aware of options by taking a class at the University level)	42%
Alternative Energy Use (Solar, Wind, Hydro, Clean Energy)	66%
Political Actions (Advocate, Campaign, Vote, or Protest)	17%
Nature Conservation/ Volunteering (Clean Parks, Rivers, Avoid littering, Plant Trees)	61%

The goal was to establish a feel for what students were willing to do in their personal lifestyles in regards to Green Building and sustainability. Of note is that 42% of students are prepared to take a class at the university level to make themselves aware of options and topics relevant to Green Building and sustainability. A cross tabulation should be done to validate data from the answers in previous questions to determine the consistency answers. Students are

actively participating in green lifestyle choices currently, as evidenced by their use of energy or water efficient appliances at 83% and recycling 94%. The movement has transformed into a lifestyle and will continue to gain momentum as it moves forward. My impressions from Purdue lead me to believe that students do have a heightened *interest* in sustainability and Green Building, but lack a consistent source of obtaining relevant information and education.

This question was meant to not only determine students *understanding* of Green Building technologies, but also help manufaturers understand what students' perceptions of acceptable payback periods when implementing Green Building features. Given an accepted industy standard of 4-5 years for ROI, students ideas about ROI are unrealistically skewed to a shorter time frame. The 12% that responded with 0-12 months have not likely had enough exposure to Green Building elements to determine realistic payback periods. Those who selected 3-5 years are more realistic and suggest that the sweet spot for simple Green Building product implementation should fall between 4 and 5 years. The data could be argued to be flawed due to the wide variety of elements that could be selected such as photovoltaic collectors vs. low volatile organic compounds (VOC). A deep analysis of these findings is beyond the scope of this project.

Table 4.15.

Purdue Survey Question #17

What is the time limit for you to start to see a return on investment when adding green elements to your home? (When the money saved exceeds the cost of the upgraded element i.e. energy efficient appliances)

Answer	Percentage
0-12 Months	12%
1-2 Years	37%
3-5 Years	35%
5-9 Years	8%
10+ Years	8%

4.3. Data from Weber State University Survey

The first question was the consent question to determine whether students were 18 years of age and to ensure that they knew that they were not being compensated for their participation as mandated by the Human Subjects Committee. The first statistically significant question posed was to obtain background and demographic data. The question was "What is your affiliation with your school?" This information could be useful when cross tabulation was done with age, *interest*, *knowledge* and motivations to go green. All classes are equally proportioned in the study from freshman to junior and 31.6% being seniors. The faculty and staff who were asked to participate had to have been enrolled in at least one class to be solicited to participate. If one were to take an average of the class of students who participated, it would fall in the junior year which is where possibly the course be located in the progression towards graduation.

Table 4.16.
Weber State Survey Question #2

What is your Affiliation with your School?	
Answer	Percentage
Freshman	20.0%
Sophomore	20.1%
Junior	20.5%
Senior	31.6%
Graduate Student	6.8%
Faculty/ Staff	0.9%

The third question was to determine age. This would be useful in determining if there were any *interest* or *knowledge* discrepancies between age groups that could be meaningful in determining the the ideal time of the proposed course in the students' academic progression or class level at which to teach it. It is of *interest* that the average age of Weber State University

students falls in the 21-25 range . This would mean that their home purchasing decisions are less limited than those students at Purdue as far as the average age at which a home is purchased or other significant purchases are made. These decisions may have involved *knowledge* about or experience with sustainability and Green Building.

A comprehensive comparison between finding at both schools will be done in Chapter 5. A balanced representation from all grade levels allow the conclusion to be drawn that students across all ages and progression towards a degree are represented.

Table 4.17.
Weber State Survey Question #3

What is your Age?	
Answer	Percentage
18-20	23.6%
21-25	28.9%
26-30	22.2%
31-40	14.6%
41-50	7.9%
50+	2.7%

This demographic question can be used to cross-tabulate responses based on major emphasis of study with *interest*, *knowledge*, prior experience, and motivations to go green. The table above also shows that a sufficient cross section of students participated in the study. Compiled with the data obtained through this question at Purdue University, a sufficient cross section of all major is represented to validate outcomes of the data.

This question was designed to determine any differences in *knowledge* or *understanding* between the main two terms used in this study. As seen below, sustainability seems to be better understood than Green Building. If the Likert scale were to be applied to the possible

answer selections below, a statistical analysis could be executed. The number 1 was associated with “Not at all familiar”, and the number 4 with “Very familiar”. The number of responses per category were then mulitplied by their appropriate number and divide by the total number of respondents. As seen by the mathmatical equation below, the mean or average scale could be discovered. As seen by the calculated mean or averages below Weber State University student are fairly familiar with both terms.

Table 4.18.

Weber State Survey Question #4

What is your Major Emphasis of Study?	
Answer	Percentage
Applied Science and Technology	10.4%
Arts and Humanities	9.7%
Business & Economics	14.7%
Education	7.7%
Engineering	5.3%
Health Professions	17.5%
Science	10.0%
Social and Behavioral Sciences	12.8%
Other Please Specify	11.8%

r= respondents

$$Mean = \frac{(r_1 * 1 \mid r_2 * 2 \mid r_3 * 3 \mid r_4 * 4)}{Total\ responses}$$

Table 4.19.

Weber State Survey Question #5

How would you rate your *knowledge/ understanding* of these terms?	
Terms	Mean*
Green Building	2.62
Sustainability	2.68

*Not at all Familiar (1)
*Unfamiliar (2)
*Familiar (3)
*Very Familiar (4)

As seen in the tables above, the *familiarity* of the term Green Building has a mean of 2.62 or somewhat familiar, but not confident enough to say familiar. The term sustainability received a mean of 2.68 or statistically familiar. This brings up the question: what, specifically, are students familiar with? Thus the next question was posed. This was not meant to be an exhaustive list, but a list of the major topics found within the Green Building and sustainability sectors.

Table 4.20.

Weber State Survey Question #6

Please indicate your *Familiarity* with and *Interest* in learning about the following:

Terms	*Familiarity* Mean*	*Interest* Mean*	Difference
NAHB Certified Green Built Homes	1.60	2.57	-0.98
LEED for Homes	1.55	2.50	-0.95
Solar Hot Water Heating	2.27	2.93	-0.66
Passive Solar Heating/ Cooling	2.25	2.89	-0.63
Sustainable or Renewable Construction Materials	2.20	2.78	-0.58
Glazing (Window) Efficiency	2.13	2.66	-0.53
Geothermal Heating/ Cooling	2.35	2.84	-0.49
Indoor Air Quality	2.52	2.91	-0.40
Solar Power (Electricity Generation)	2.73	3.05	-0.31
Hydro Power	2.44	2.73	-0.29
Wind Power	2.71	2.99	-0.28
Insulation Ratings	2.33	2.56	-0.23
Recycled/ Reused Building Products	2.63	2.82	-0.19
Appliance Efficiency	2.76	2.70	-0.06
Lighting Efficiency	2.76	2.80	-0.04
Water Conservation	3.03	3.05	-0.02
Average of all Means	2.39	2.80	-.41

*High (4)
*Medium (3)
*Low (2)
*None (1)

As seen above, using the likert scale applying a 1 to no *familiarity* and 4 to high, a mean could be derived. The higher the number, the more familiar students were with a particular topic. Water conservation and lighting efficiency were the lowest rated or had the lowest level of *familiarity*. Certification seems to have the lowest level of *familiarity* with Weber State University students, but also have the greatest differential in wanting to learn more. Water conservation seems to be well *understood* and little *interest* above the existing *knowledge* exists so this is a topic that would require little attention if any. Solar hot water heating as well as passive solar design techniques are topics that have a high differential between existing *knowledge* and *interest*. This data could be used to establish what areas students already *know* and which areas could be taught in greater detail. This chart could be used to stage when and how long each topic is discussed or discovered in the class environment.

The topics that were least familiar to students were certifications that incorporate all of the topics. Both the NAHB Certified Green Built Homes, and LEED for homes scored 1.60 and 1.56 respectively. The average *familiarity* mean of all topics is 2.39 wheras the *interest* mean is 2.80 suggesting that students have a differential between existing *knowledge* and *interest* of .41.

Applying the same methodology as above, this question analyzes the average or mean *interest* in learning more about the topics of sustainability and Green Building. Further comparison of the *knowledge* vs. *interest* later is found in Chapter 5.

Table 4.21.

Weber State Survey Question #7

In what fields have you had previous formal education where sustainability was addressed? (Select all that apply)	
Answer	Percentage
Geography	22.6%
Biology	23.8%
Environmental Science	29.1%
Economics	11.5%
Design	10.3%
Construction	10.8%
None	38.3%

The table above shows where students have had previous formal education where sustainability was addressed. Notable is that 52.9% of respondents have had exposure to sustainability curricula within the *environmental* realm which includes Biology and Environmental Science. It is also interesting that 38.3% of respondents have had no exposure to formal curricula on sustainability. Only 11.5% of students reported having formal education about sustainability in economics, but still find this to be their highest rated motivating factor as established earlier in this paper. The categories chosen above are the natural locations where sustainability curriculum could be addressed quite easily without changing content in the courses a great deal. Sustainability and Green Building affect each of these areas quite heavily and, as shown in the literature review, are projected to play an increasing role in the future. My theory is that sustainability and Green Building will find themselves increasingly becoming a part of the content taught in these courses due to current event discussions that surround them.

Political action is not on the minds of students, whereas recycling, reducing waste, reusing materials are. Of those students surveyed, 61% are using alternate transportation methods and 72.8% of those are using energy saving habits. Only 9.1% of students have been

involved with sustainability or Green Building research professionally or academically, but 27.1% have taken the initiative to educate themselves or train others about sustainability or Green Building practices.

Table 4.22.

Weber State Survey Question #8

Have you done any of the following? (Select all that apply)	
Answer	Percentage
Researched, Designed or Built Green Structures/ Technologies Professionally	9.1%
Political Action such as Writing Letters to Senators, Protests, Campaigning, Boycotts, Membership in Greenpeace (or other) etc.	10.9%
Used Alternative Energy Sources (Solar, Wind, Hydro)	15.7%
Educating Yourself or Trained others about Green Building/ Sustainability Practices	27.1%
Changing Shopping Habits to Support Green Businesses	36.8%
Participated in Nature Conservation (Planting Trees, Trash Cleanup, etc.)	58.9%
Started Energy-Saving Habits	72.8%
Used Alternate Transportation Methods (Mass Transit, Bike)	61.0%
Recycling, Reducing Waste, Reuse, etc.	93.0%

Table 4.23.

Weber State Survey Question #9

What would be your *interest* level in taking a course about ways to "Green" your existing or future home?	
Levels of *Interest*	Mean*
	2.98
*No *interest* (1)	
*Slight (2)	
*Moderate *Interest* (3)	
*High *Interest* (4)	
*Extreme *Interest* (4)	

Table 4.24.

Weber State Survey Question #10

How likely would you be to take a course about the following "Green Building" topics, offered as a general elective and fulfilling a breadth requirement?

Class Description	Mean*
A Class about Steps to Greening your Home	2.74
Environmental Appreciation	2.56
Environmental Issues & Economic Policy	2.53

*Very Un-Likely (1)
*Unlikely (2)
*Likely (3)
*Very Likely (4)

The next question addresses *interest* levels in taking a course about ways to "Green" with an existing or future home. An almost perfect bell curve is created. This proves that a moderate *interest* in taking such a course as is proposed. This could be sufficient to prove that there is enough demand to create a general elective course on greening a home and using the *interest* means from Question 6 above to determine the order and depth of the content. It is of note that 64.4% of respondents have moderate to extreme *interest* in taking such a course. This could be correlated with the high level of *interest* in home certifications that deal with all of the topics surveyed that fall within the realm of sustainability and Green Building. Only 12.3% of students profess to having no *interest* in learning about ways to green their homes. A comparison of age, affiliation, and *interest* in the course will be examined in Chapter 5.

The next question was a follow up question to determine the type of approach to Green Building to which students would be most receptive. This could be compared to their personal motivations falling into the *environmental*, *economical*, or *social* categories that were established earlier in this paper as being the three most prevelent motivational factors behind

the sustainability and Green Building movements. Answers to this question reveals that students are more *interested* in taking a class that addresses solutions to economic problems such as efficiency and logical steps that they can take to green their home than theory based courses on *environmental* appreciation and economic policy. If the Likert scale were applied to this question a mean of 2.74 for the greening your home class is calculated, 2.56 for *environmental* appreciation, and 2.53 for *environmental* issues & economic policy.

Analysis shows that 75.5% feel it is a good thing and 10.1% are passionate advocates. Even if *interest* and the other questions posed to students are not sufficient to determine that a general elective course should be developed for all students in all majors, this should tip the scales in favor of establishing need for such a course. If 85.6% feel that it is a good thing or passionately advocate it, institutions should be providing education about what the movement really is and how they can participate.

Table 4.25.
Weber State Survey Question #11

What is your Opinion of Green Building in general?

Opinion	Percentage
*I think it is a waste of time and effort (1)	2.1%
*It doesn't bother me (2)	7.0%
*I think it's OK for others to do it (3)	5.3%
*I think it's a good thing (4)	75.5%
*I'm a passionate advocate (5)	10.1%



Figure 4. 2. Weber State University Wordle from an open opinion question (type 4 words)

The next question allowed students to write up to 4 keywords (not a sentence) conveying their personal *understanding* of "green" building or sustainability. The example was given "Peanut Butter: Creamy/ Sandwich/ Brown/ Sweet. The responses were analyzed to establish redundancies. A "wordle" was created to help visualize when a particular work was used to convey their personal *understanding* of Green Building. Wordle's generate "word clouds" from text that you provide. The clouds give greater prominence to words that appear more frequently in the source text. As can be seen the most common terms used were efficient, environment, and recycle. There were some negative connotative terms that were prevalent as well such as expensive. Notably, the negative terms were not nearly as prevalent as the positive connotative terms.

Questions 13 and 14 should be compared to show the difference between students' personal motivations to go green vs. what they percieve the others motivations are. The likert

scale of analysis shows that *economic* concerns are their foremost motivation to be more green. *Social* motivations are second with *environments* relatively close in their personal motivations to be more green. Getting a return on investment for their green efforts is foremost in students minds. As shown on the wordle above, there is a perception that greening a home is expensive, indicating that this is yet another area that could be addressed in the course.

Table 4.26.

Weber State Survey Question #13

Rank your Personal Motivation to become more "Green"?
(Order YOUR preference from 1-3)

Motivation	Mean
Social (Peer Influence or Popularity of Green)	2.02
Environmental (Save World)	2.08
Economical (Save Money)	1.96

The comparison between these two questions reveals that students perceive *social* motivation to be the highest for others, but *economical* and *environmental* are not statistically much different. Students percieve all three motivations affect society equally to being more green. It would be interesting to determine exactly why students feel this way, but that is beyond the scope of this research project. This data forced a ranking of the motivations and did not allow cross motivations to be evaluated.

Table 4.27.

Weber State Survey Question #14

Rank what you perceive motivates SOCIETY to be more "Green"?
(Order SOCIETIES preference from 1-3)

Motivation	Mean
Social (Peer Influence or Popularity of Green)	2.00
Environmental (Save World)	2.01
Economical (Save Money)	2.09

Table 4.28.

Weber State Survey Question #15

If you were considering building or buying a home, which of the following would most likely motivate you to incorporate Green Building principles into your own house?

Motivation	Percentage
Concern for the Environment & Natural Resources	40.7%
Going with the flow- Popularity of "Green"	2.6%
Getting a Return on Investment	56.6%

"When the wallet hits the register", was explored in this question. 56.6% of respondents were monitarily of economically motivated whereas only 2.6% were willing to put their money where their mouth was, having previously stated that they were *socially* motivated.

The application of this data could be argued due to the wording chosen in the question and that it did not follow the Likert scale as the two previous questions had done. This was done for triangulation purposes as explained above; comparison of the last three questions should be done cautiously. In all cases *economic* motivation was selected as being the greatest motivator to go green. This falls in line with the study previously mentioned in Chapter 2.

Table 4.29.

Weber State Survey Question #16

What are you prepared to do in your personal lifestyle in regards to "Green Building" and Sustainability? (Select all that you would be willing to do)

Answer	Percentage
Consumer Change (Buy more Green Building Products i.e. Flooring, etc.)	64.0%
Recycling	95.8%
Energy and/ or Water Efficient Appliances	88.2%
Education (Learn and be aware of options by taking a class at the University level)	57.4%
Alternative Energy Use (Solar, Wind, Hydro, Clean Energy)	70.6%
Political Actions (Advocate, Campaign, Vote, or Protest)	22.5%
Nature Conservation/ Volunteering (Clean Parks, Rivers, Avoid	65.1%

littering, Plant Trees)

It was important to establish a feel for what students were willing to do in their personal lifestyles in regards to Green Building and sustainability. Of note is the 57.4% of students who are prepared to take a class at the university level to make themselves aware of options and topics within Green Building and sustainability. A cross tabulation should be done to validate data from the answers in previous questions to determine the consistency answers. It is evident that students are actively participating in green lifestyle choices currently by recyling as is further established by 88.2% using energy or water efficient appliances. The movement has transformed into a lifestyle and will continue to gain momentum as it moves forward. My impressions from Weber State University lead me to believe that students do have a heightened *interest* in sustainability and Green Building, but lack a consistent source of obtaining that information and education.

Table 4.30.

Weber State Survey Question #17

What is the time limit for you to start to see a return on investment when adding green elements to your home? (When the money saved exceeds the cost of the upgraded element i.e. energy efficient appliances)

Answer	Percentage
0-12 Months	19.3%
1-2 Years	36.3%
3-5 Years	30.2%
5-9 Years	7.1%
10+ Years	7.2%

This question was meant to not only be a determinate factor in student *understandings* of Green Building technologies, but also a tool to help manufaturers understand students

perceptions of acceptable payback periods when implementing Green Building features. The 19.3% that responded with 0-12 months have not had enough exposure to Green Building elements to determine realistic payback periods. Those who selected 3-5 years are more realistic and suggest that the sweet spot for simple Green Building product implementation should fall between the years of 4 and 5 years. A deep analysis of these findings is beyond the scope of this project.

4.4. Summary

Although a detailed look into the data collected at each university has been established, a comprehensive comparison and contrast of the data to find emerging themes and essences meaningful to this research. The data collected and shared in this chapter is meaningful for internal check and balance purposes to evaluate how well sustainability and Green Building is being taught and understood by the students.

CHAPTER 5. THEMES AND ESSENCES

The previous chapter analyzed the data collected from each university separately and drew some conclusions. This chapter will combine the results and show a comparison side by side between the two universities. This chapter integrates the various data sources to identify the invariant themes that emerged. The chapter will introduce each theme as it emerged and provide supporting narratives.

5.1. Themes across All Data Sources

While the background and demographic data were interesting and enlightening, the major purpose was to allow cross tabulation between age groups, affiliations, majors, and *knowledge*, *knowledge* gaps, *interest* levels, and motivations with respect to sustainability and Green Building. The comparison of the data between schools and combined revealed several emerging themes, as shown in table 5.1.

The background and demographic data will be compared first to establish the baseline from which each of the future comparisons will be drawn. The first comparison is the students' affiliation with their respective universities. The options given were freshman, sophomore, junior, senior, graduate student, and faculty/staff. If one takes an average of the respondent from each school it provides a mean progression of 2.85 years or Junior at Weber State University, and 3.11 or Senior at Purdue University.

Table 5.1

5 Themes Emerging in this Study.

Themes	**Description**
1. Existing *Knowledge* or *Understanding*	Age, affiliation, and major are significant factors, as well as prior exposure to formal curriculum on Green Building.
2. *Interest* Level in learning more	*Interest* seems to be universal across all majors, ages, and affiliations
3. Opinion & Feelings	Age and major are significant factors
4. Lifestyle Choices Now & Future	Students are embracing the green movement but lack *knowledge* of how to move forward
5. Motivations to go green	*Economic*, *environmental* seem to motivate, but not *social* concern

The average age of students participating in the study at Purdue University was between the ages of 18-20 and 21-25 (approximately 20.8 years of age) as discussed earlier in this paper. The average age of students participating in the study at Weber State University was between the ages of 21-25 and 26-30 (approximately 25.5 years of age). The combined approximate average was 25 years of age. Historically, this is the age at which students are entering into major decisions that have significant Green Building implications. Students are deciding where to live, whether to buy a home, whether to build a home, or setting a budget of living expenses. It is significant to note that this sampling is the prime location to market green technologies and features of which homebuilders and manufacturers should take note.

As was stated in Chapter 1, the primary objective for the study was to “Analyze a good cross section of the student population which included more than just the archicture, construction, and engineering disciplines to determine if there was *interest* in sustainability and Green Building”. While some majors are not well represented at each university individually, collectively the data is sufficient to establish a baseline across all majors and colleges is represented to validate the data and comparisons taken from this source. With the broad respondent population being suffiently spread among all colleges and majors, this study enables a parallel to be drawn between the respondents of this study and the general student population at both universities and country as a whole. Themes from the data “verify that sustainability and Green Building are on the minds of students at the university level and is of *interest* to them to learn more about the technology and its implications in our built environment.

The second objective was to “develop a curriculum that touches or will touch on all aspects of Green Building and sustainability in the built environment”. In order to accomplish this several parallels needed to be drawn between current *knowledge* and *interest* levels in learning more about those topics. These parallels would “identify areas in which current curriculum is sufficient as well as areas in which the content could be modified based on the data collected in each area.” Further, parallels between the top three motivations to implement Green Building or sustainability elements would need to be drawn. These areas are identified in the research as economic, social, and environmental. As was mentioned above in Table 5.1, themes emerged from this study that is directly related to the objectives stated in Chapter 1. Each theme will be expounded on in greater detail in the following sections; Existing *knowledge*

and *Understanding*, *Interest* in learning more, opinions and feelings, lifestyle choices now and future, and motivations to go green.

Also outlined in Chapter 1 were eight research questions. Each of these questions is answered in the following 5 themes. Question 1 or students' *understanding* of sustainability and Green Building is answered in the first theme entitled "Existing *knowledge* and *understanding*". Question 2 or students' attitudes and concern with respect to sustainability and Green Building are answered in the third theme entitled "Opinions and Feelings". Question 3, or actions students are prepared to take, or have taken, to realize a more sustainable lifestyle is answered in the fourth theme entitled "Lifestyle Choices Now & Future". Question 4 or the ranking of personal vs. perceived general societal motivation to go green is addressed in the fifth theme "Motivations to go green". Question 5 or the answer to the question; is Green Building worth it, is also addressed in the fifth theme "Motivations to go green". Question 6 or demographic data (Age, affiliation with school) draws parallels between previous exposure to formal curriculum teaching Green Building or sustainability in other fields to their *familiarity* and *understanding*. This is explained in the second theme "*interest* level in learning more about sustainability and Green Building". Question 8, or the overall *interest* levels of students from all disciplines in taking a course potentially entitled "Ways to Green your Existing or Future Home", is answered in theme two "*interest* level in learning more about sustainability and Green Building".

A comparison of themes two and three are used to delineate outcomes and implications of the data on curriculum in Chapter 6. This is where Question #7 is answered in greater detail to "determine the specific areas within sustainability and Green Building with which students

are most familiar and have the most *interest* in learning more from the list of 16 items discovered as the most important topics taught within Green Building and sustainability in the built environment.

Students are *interested* in learning more about sustainability and Green Building and would support the creation of a general elective course that would give them a central course in which the applicable *knowledge* surrounding these topics could be taught. Students are prepared for such a course because of their age, education, and current and future living situation that will include decisions to be made about implications of these topics.

5.1.1. Existing *Knowledge* and *Understanding*

The primary objective of the study to determine "what students were already familiar with, and in what areas they were lacking", in order to develop a multi-disciplinary curriculum that could be offered as a general elective at the university level. Two key words of phrases, Green Building and Sustainability, were selected to first determine what level students would report as their *familiarity*. A comparison of students at both universities reported *knowledge* or *understanding* is shown in Figure 5.1. The data clearly shows that the majority of students report being "familiar" with both terms.

The data was not statistically differentiated, so it was determined that a different system to analyze the data would be used. A Likert scale (Naoum, 2007) was used to assign a 1 to not at all familiar and a 4 to very familiar. This allowed the exact statistical mean to be discovered for each of the terms. Figure 5.2 shows the mean comparisons of each university as well as the overall mean value associated to Green Building and Sustainability.

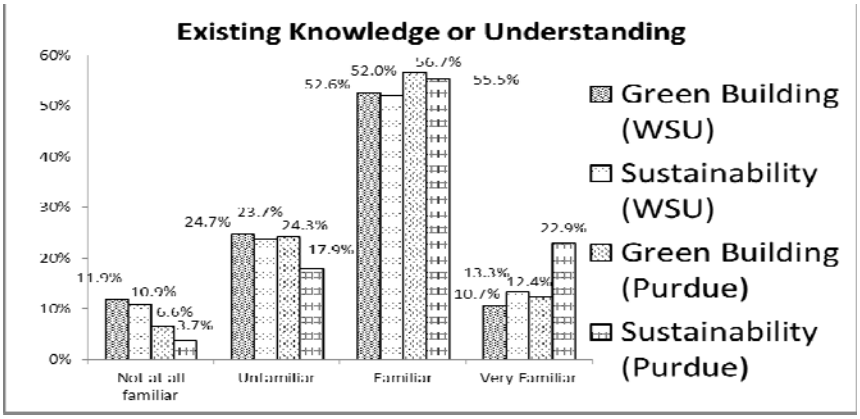


Figure 5.1 Existing *Knowledge* or *Understanding* of Green Building & Sustainability

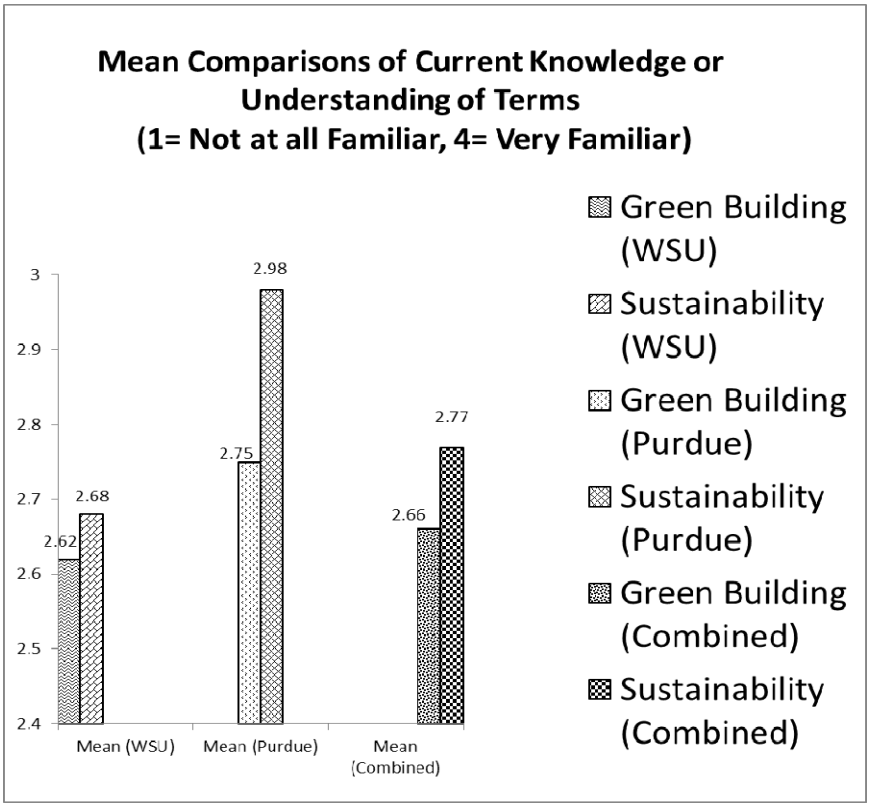


Figure 5.2 Mean comparison of Current *Knowledge* of Green Building and Sustainability

It is evident that students understand or have more *knowledge* about sustainability than Green Building. Sustainability is much broader in its application to various fields of study and

therefore it is not surprising that when surveying a large cross section of students from all disciplines that this would be the outcome. Green Building has more applicable meaning for students that are nearing the home buying stage of their lives, and therefore the study concentrated more on the built environment than a holistic approach to sustaiable lifestyles.

When looking at the comparisons between schools, Purdue is doing a much better job at providing outlets for students to obtain relevant *knowledge*. As seen in figure 5.3 below, students at Purdue have been exposed to courses addressing green more than students at Weber State University in all major categories except geography. The mean for Purdue students current *knowledge* is statistically significantly higher for both Green Building and sustainability terms.

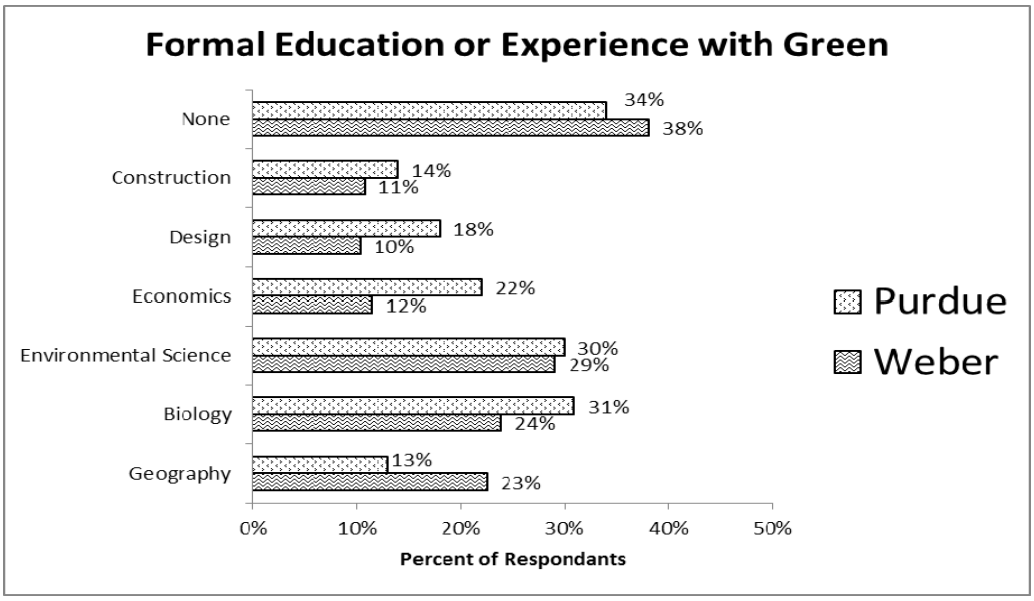


Figure 5.3 Comparison of prior education or experience with Green Building curriculum

Another note of interest is the low number of students that are reporting having been exposed to any curriculum addressing green in design and construction. It has been established

earlier in this paper that Green Building is a significant portion of those industries and is only projected to grow. There is a disconnect somewhere at WSU as is evidenced in the chart below. Only students reporting that their major emphasis of study was Applied Science and Technology were included and compared against their reports of being exposed to sustainability in the curriculum of prior courses taken. This would include anyone with an engineering, architecture, or construction degree. Only 55.1% of the Weber State and 58.3% of Purdue students reported having been exposed to sustainability or Green Building in courses teaching design or construction. In my opinion, that is too low, or we are masking the things we teach as something students do not recognize as being sustainable or Green Building.

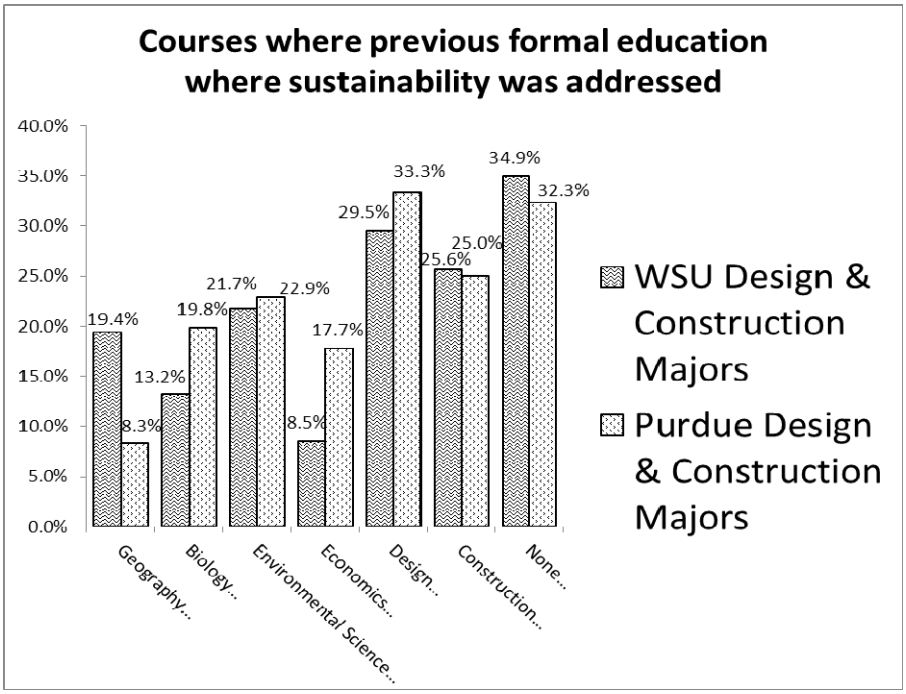


Figure 5.4 Prior Education for Design & Construction Majors Comparison

There is evidence that proves that Purdue is doing a better job teaching about sustainability and Green Building, but Weber State University is slightly better at teaching

sustainability in construction courses. The reasons for these discrepacies are beyond the scope of this project, but are worth further investigation and study. Is it a regional education flaw, or is it statistically insignificant? It would be interesting to do a follow up study on what students *knowledge* comparisons are when entering college to determine if it is a deficiency in the curriculum taught in elementary and secondary education.

In order to "develop a mulit-disciplinary curriculum that could be offered as a general elective at the university level", a *familiarity* index was extracted from the respondent data. *Familiarity* was the benchmark of determining existing *knowledge* of students reported on specific topics found withing Green Building and Sustainability. A formal comparison of *familiarity* to *interest* was done to determine which topics and how much emphasis each topic should receive. These topics were chosen from the literature research and are meant to be a representative list of the most common topics that could be covered in a class that is being proposed.

A comparison of the reported "*familiarity*" of students at both universities comprises figure 5.5. Water conservation is the only topic being taught better, or students were more familiar with, at Weber State University compared to Purdue University. This could also be due to the fact that Weber State University is located in an arid climate, and water conservation is a big issue of which all residents are well aware of in the summer. All other topics had a higher *familiarity* or existing *knowledge* being reported by Purdue University students. Again another verification that the midwest is doing a better job teaching sustainability and Green Building.

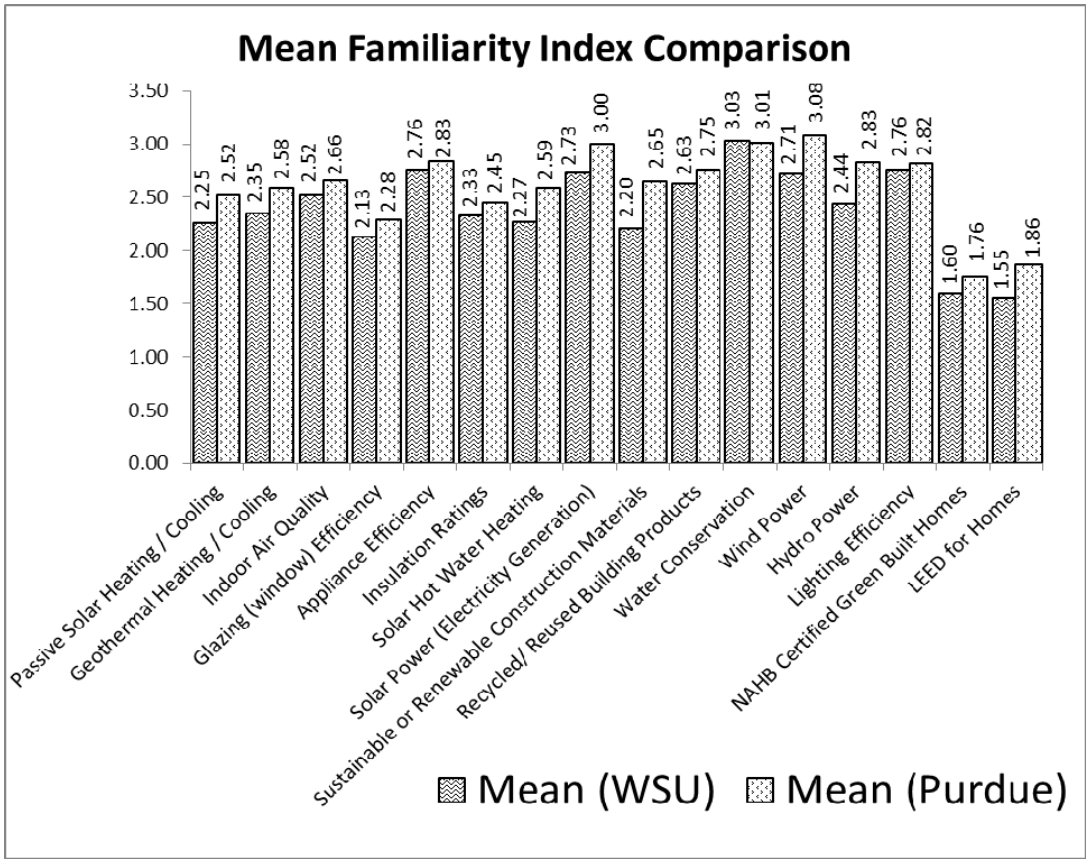


Figure 5.5 Mean *familiarity* Index comparison

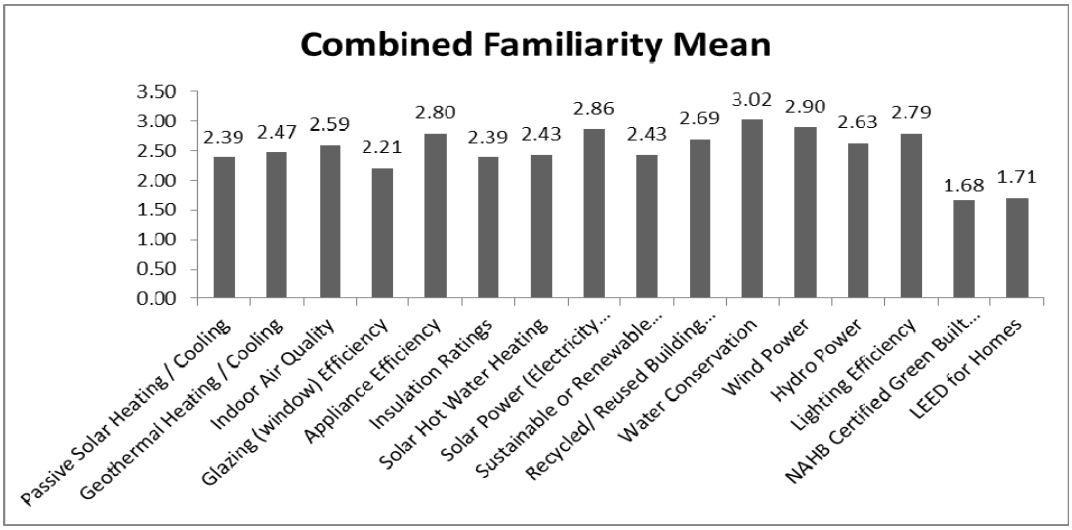


Figure 5.6 Combined Mean *familiarity* Index

From these figures we learn that water conservation is the only topic receiving a moderate *familiarity* rating index. Wind power, solar power, appliance efficiency, and lighting efficiency are topics that are receiving slight to moderate *familiarity* rating indexes. It is significant to note certifications like LEED and NAHB CGB have very low *familiarity* indexes but contain all of the topics listed within them. It is apparent that a lot of *knowledge* gaps exist between elements that typically work together such as passive solar heating and cooling compared to insulation ratings and glazing (window) efficiency. The next section of the data analysis will be to determine *interest* levels in students learning more about sustainability and Green Building.

5.1.2. *Interest* Level in Learning more about Sustainability and Green Building

The next step was to determine what students reported as their *interest* levels in the same 16 topics identified above in the familiarity or existing *knowledge* theme. *Interest* levels run high in both schools, but again Purdue edges out Weber State in all categories. A high level of *interest* seems to exist in alternative energy sources and the lowest level of *interest* in certifications like LEED and NAHB Certified Green Built.

It is significant to point out that the largest discrepancies of *interest* between schools are found in wind power, hydro power, and solar power. This is attributed to the readiness of Purdue students to be educated on alternative energy. It also points out that passive solar; IAQ, geothermal heating & cooling, and solar hot water generation are all topics that have statistically equal levels of *interest* from either schools or all students generally. Students from both universities are most *interested* in were solar power, water conservation, and wind power.

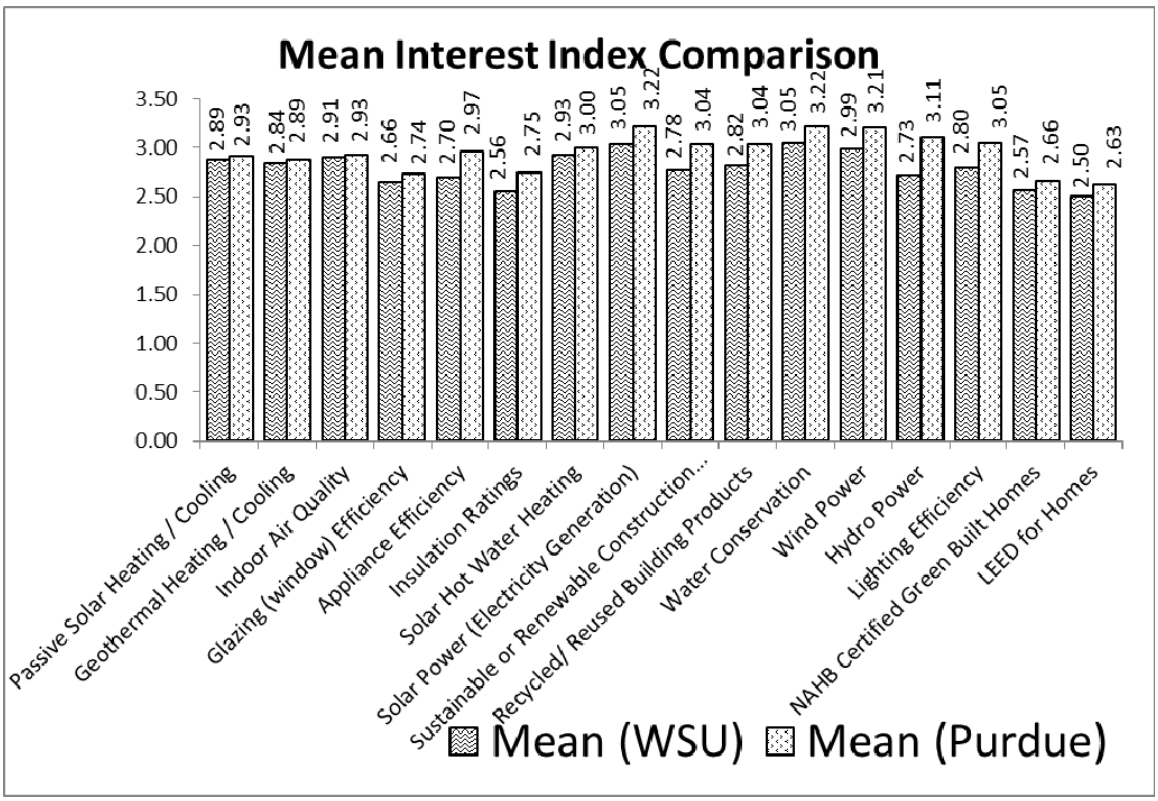


Figure 5.7 Mean *Interest* Index comparison

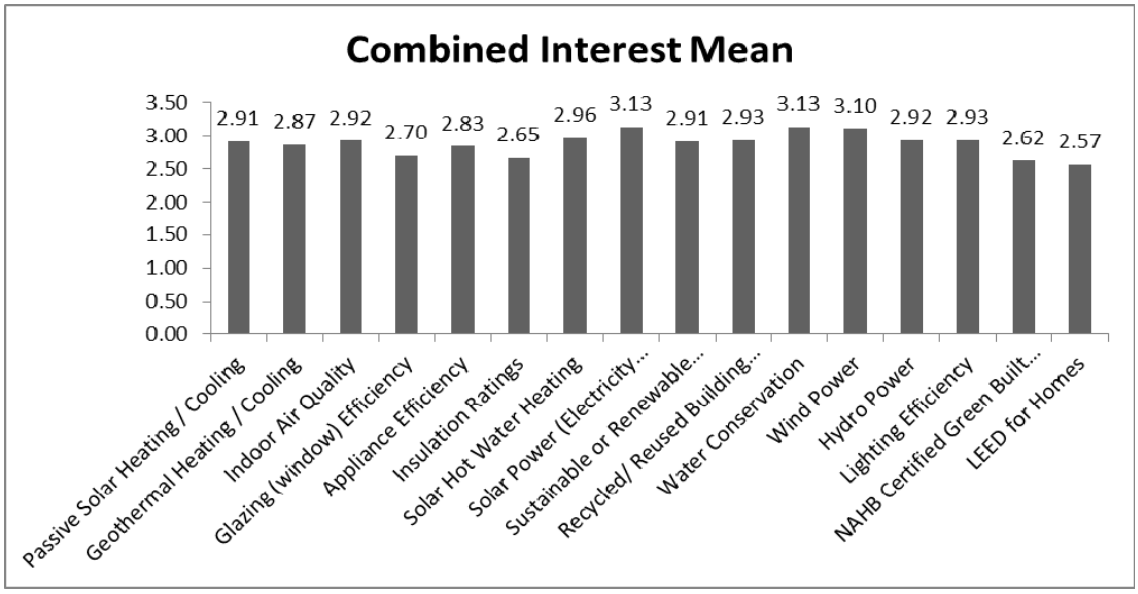


Figure 5.8 Mean Combined *Interest* Index

The data extrated above allows an implied response to the question of whether students are *interested* in taking a course of ways to green their current of future home. The question below uses the Likert scale (Naoum, 2007) to determine what students' *interest* levels are in such a course. There was an almost perfect bell curve of responses to the question.

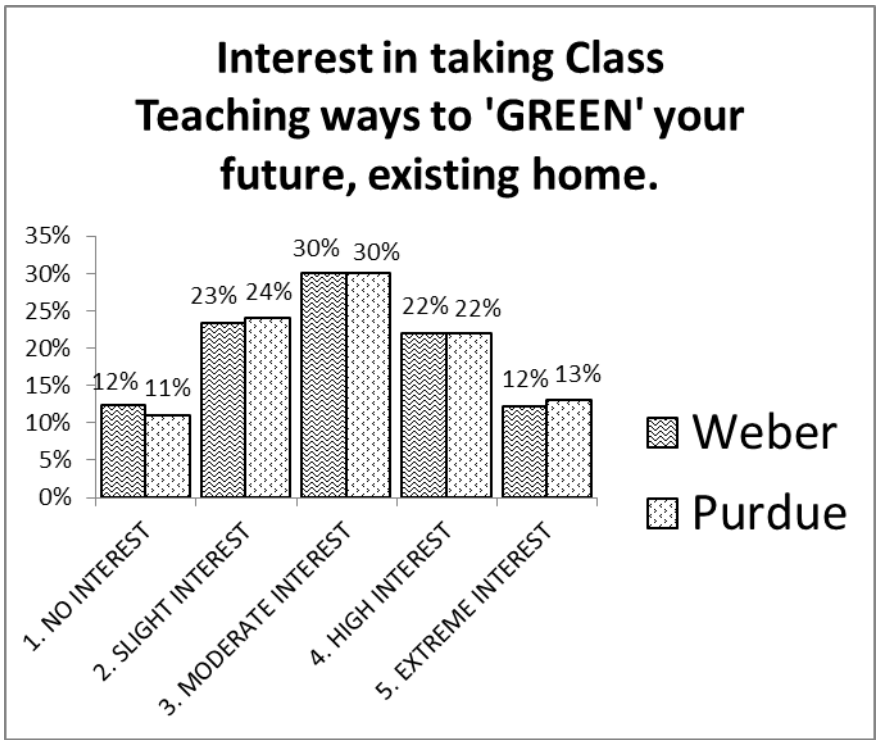


Figure 5.9 Interest in taking a class on Green Building

The data is consistent as 64% of respondents expressed moderate to extrement *interest* in taking a course. The comparison of the two schools is striking. Each category is statistically equal. The mean ends up being 2.99. It is safe to say there would be sufficient *interest* and enrollment in a course that addressed the topics discussed and survey in this study.

A follow up question was posed as to what kind of approach to teaching the topics surrounding Green Building would be of most *interest* to students. The question was worded in

such a way as to determine students motivations surrounding curriculum content. Steps to greening one's home was meant to take the motivation of *economic* benefit, whereas enviromental appreciation would take the motivation of *environmental*, and *economic* policy the motivation of *social*. The comparitive and mean results are shown below.

The data shows that the most effective way to teach Green Building and sustainability is through *economic* or efficiency calculation methods. If an instructor can tie a monetary improvement to the decision to implement a particular technology, the more likely the students' *interest* and inquiry will remain high.

Weber State University has a much higher Likert scale (Naoum, 2007) mean differential than Purdue. Students at both institutions would prefer a course based on the *economic* motivations involved with each topic outlined above as they further their education in Green Building. It is mixed between *environmental* and *social* motivations as to what students would prefer for a secondary look at green education.

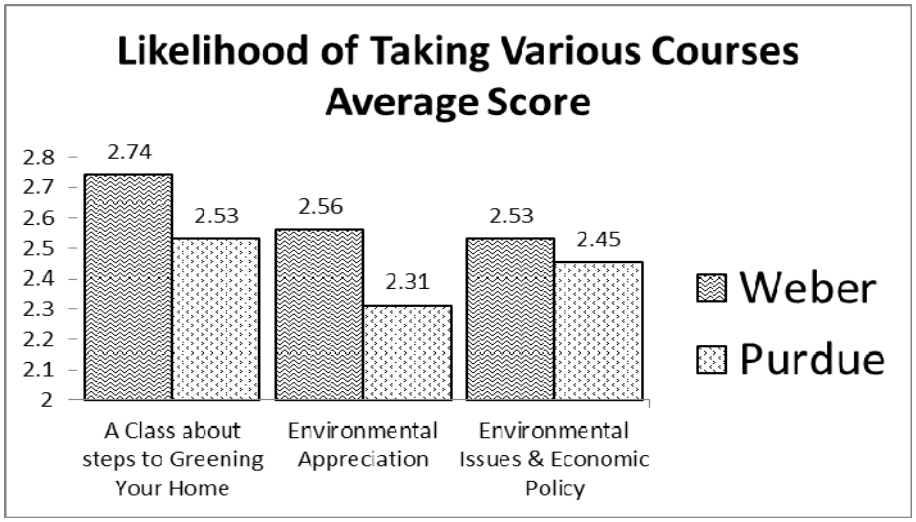


Figure 5.10 Content approach to Green Building curriculum development

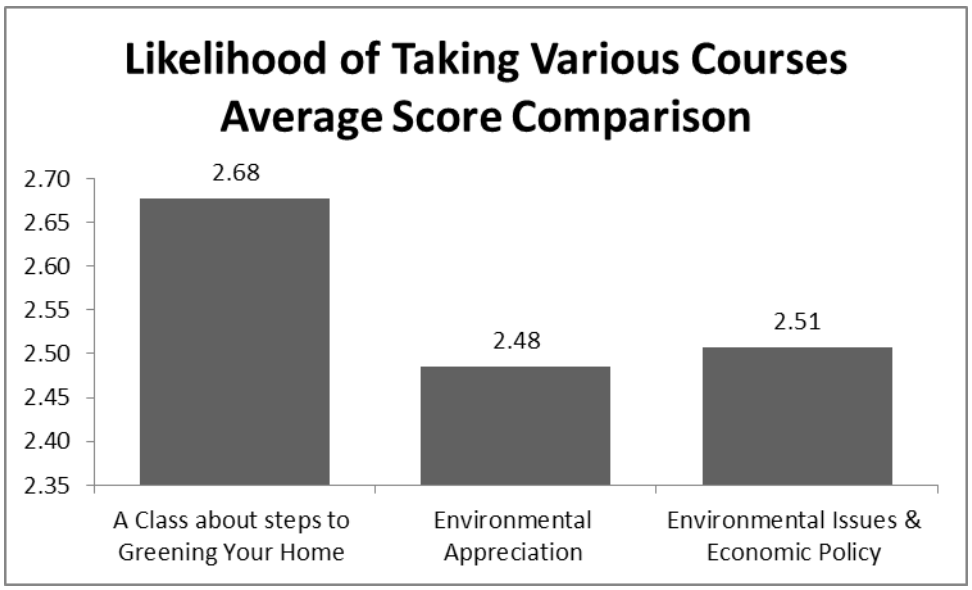


Figure 5.11 Content approach to Green Building curriculum development Combined

Once the results are compiled it is clear that students would prefer the approach to sustainability and Green Building education to be primarily *economic* or return on investment analysis. Secondarily, they are *interested* in learning about the decisions and political issues they will face in the design and construction of their buildings and homes. The last area of *interest* to students would be to study the environmental impacts of building practices.

5.1.3. Opinions and Feelings

Students have grown up hearing about Green Building and sustainability, but how much do they really *know* about it? What are their feelings towards it? Are they embracing the movement, or are they bugged by it? These are all questions this study has answered. I have heard in the past, "It is a bunch of tree huggers trying to save the polar bears!" The study gave students the opportunity to express their opinions and feelings in a variety of ways. The Likert

scale (Naoum, 2007) allowedthem to select from “it is a waste of time” all the way up to “I’m a passionate advocate”.

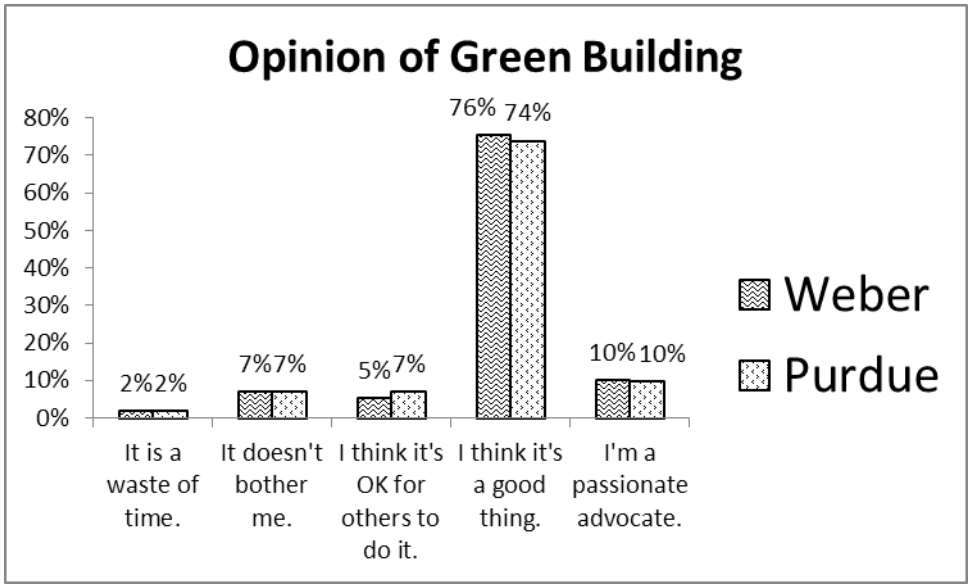


Figure 5.12 Opinions of Green Building

Students at both schools are almost identical, in attitude. This leads me to believe that this is a good indicator of the student population across the united states. This question was followed by an inquiry about what specific things they had done in their lives that had sustainable ties to them. For example, I asked if they participated in recycling and 93% reported they were actively doing it. Another surprising finding was 71% are practicing energy saving habits and 64% are using alternate forms of transportation such as mass transit, bus, or bike.

The responses are summarized in figures 5.13 & 5.14, selected from the following;

- Recyling, reducing waste, reuse, etc.
- Researched, Designed or Built Green Structures/ Techologies Professionally

- Changing shopping habits to support green businesses
- Staring energy-saving habits
- Used Alternate Transportation methods (Mass Transit, Bike)
- Used Alternative Energy Sources (Solar, Wind, Hydro)
- Participated in Nature Conservation (Planting trees, trash cleanup, etc.)
- Participated in Political actions such as writing letters to Senators, Protests, Campaining, Boycotts, Membership in Greenpeace (or other), etc.
- Educated Yourself or Trained other about Green Building/ Sustainability practices

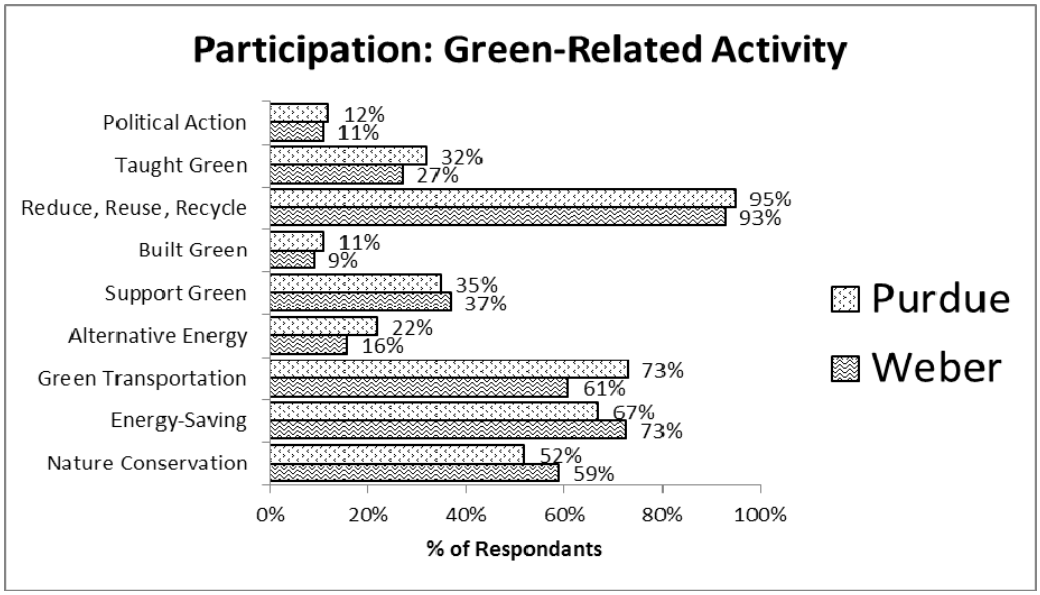


Figure 5.13 Green or Sustainable Actions taken comparison

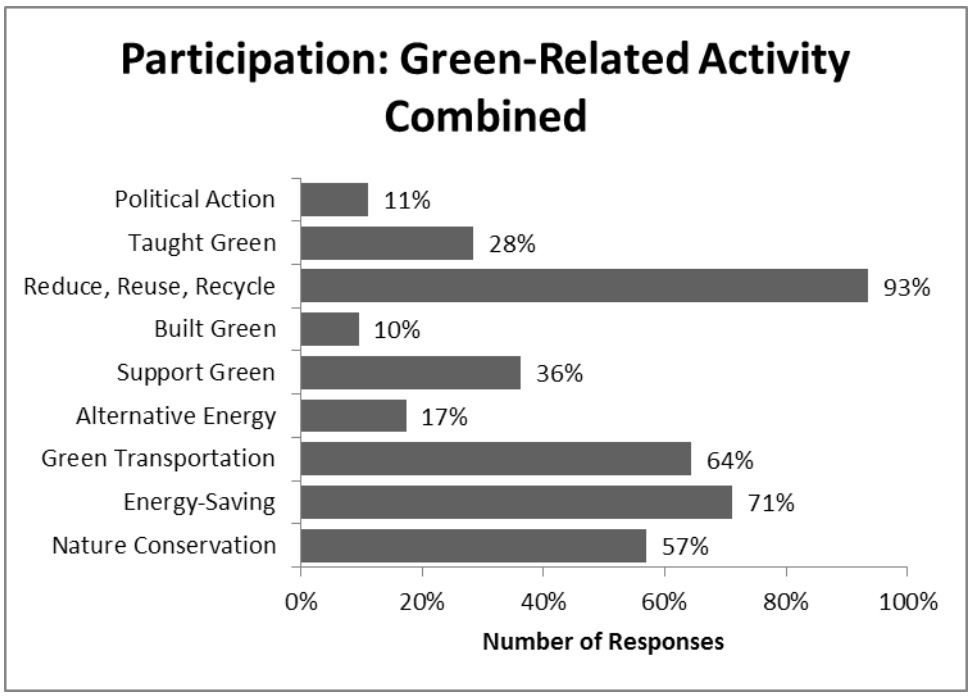


Figure 5.14 Green or Sustainable Actions taken combined

The second method used to determine opinions and feeling towards Green Building and sustainability was to allow students to type in his or her own responses. This solicited four words from each respondent that described their feelings about the topics of discussion. The students were given the example of peanut butter which could potentially solicit the following responses; creamy, sandwich, brown, and sweet. These database of words was then applied into a Wordle. The Wordle makes words that are more prevelant in that database larger and creates images as seen below. I was interested to see if there were any differences between age segments that participated in the study. I took the words that were submitted in the age groups of 21-25 at Weber State and compared them with the age group of 31-40. This determined that there seem to be many more positive opinions and feelings in the younger group. Environment, energy, efficient, conservation are all words they used, where expensive

was the most used word in the older age group. Words like waste, hoax, and hyped start to show up as well in the older age group when most words used in the younger group tended to be more positive.



Figure 5.15 Wordle from WSU respondents age 21-25



Figure 5.16 Wordle from WSU respondents age 31-40

5.1.4. Lifestyle Choices Now & Future

This was followed up by asking what actions they are willing to take in the future. Within this question they had the opportunity to select that they were willing to take a course about actions that can be taken in their own homes, to be more green. This addresses the lifestyle they are willing to embrace. Some of these will require changes to be made in their lifestyles currently, but some will require little work such as recycling and using energy efficient appliances. Students are not *interested* in political action, but 50% are willing to take a class on how to green their homes. I feel comfortable that the students that participated in this study have great attitudes towards Green Building and sustainability, but lack the formal education needed to make informed decision as to what products they use and put into their homes.

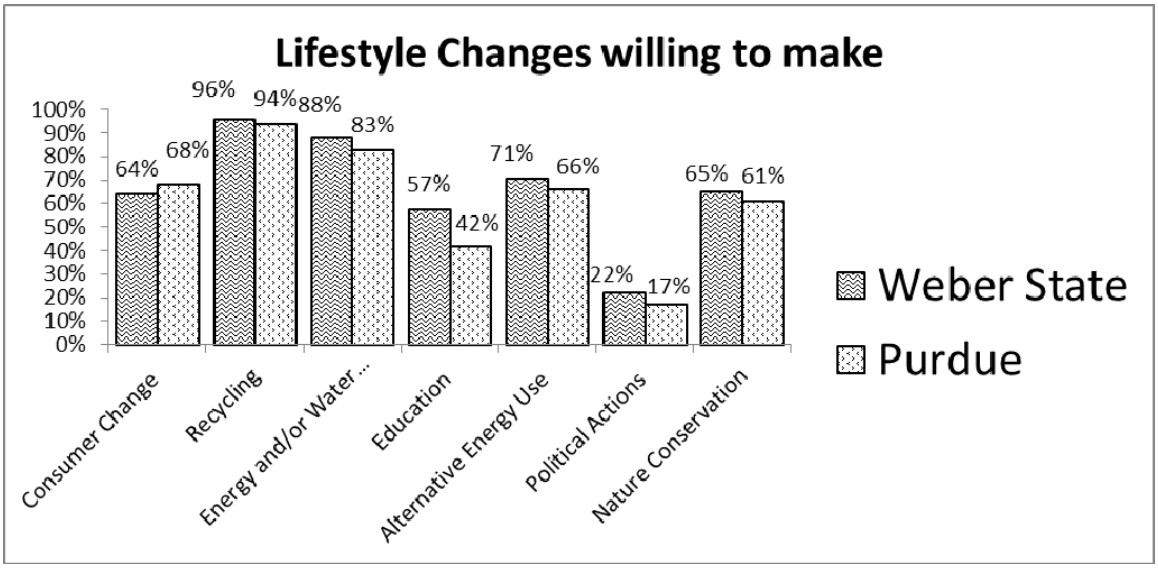


Figure 5.17 Personal lifestyle changes willing to make comparison

The comparison between schools is statistically relevant. This may in fact be indicative of how students across the U.S. feel about sustainability and Green Building practices. It is

significant to point out that 57% of Weber State students were willing to take a class on greening their lifestyles whereas only 42% of Purdue students were willing to do the same.

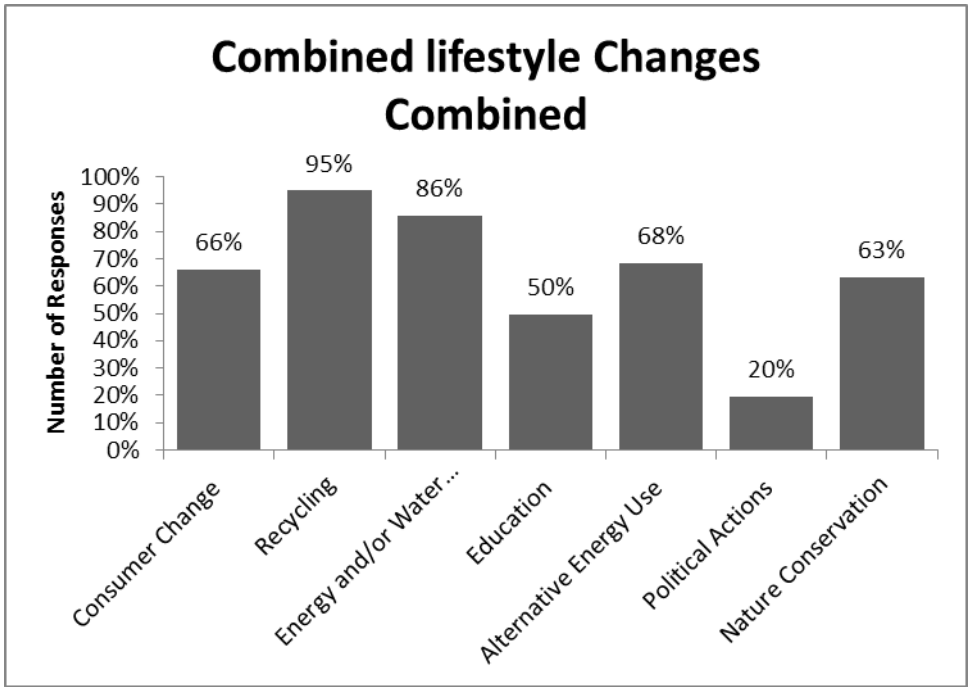


Figure 5.18 Combined lifestyle changes willing to make

5.1.5. Motivations to go Green

In order to determine what motivates students a series of questions to enable a comparison to data that was found during the literature review process that stated that going green can be tied to one of three motivations; *economic*, *social*, *environmental* (Fumiyo, 2007). I wanted to see what students would rank as their own personal motivations to go green. They were allowed to rank from 1 to 3, with 1 being the most influential motivation to go green. The study then asked them to rate what they perceived society's motivation to go green. Not surprisingly the answers were quite different.

Economical motivations were the number one motivator in both scenarios, but students perceived that societal pressure was equal in motivating society to go green. Students also perceived the society doesn't really care much about the environment, or at least is not motivated by it to make changes. Students are *economically* minded and motivated, but also have an eye out for the environment. Students are not going green to go with the flow or "fad", but really think it is a good thing and will participate as long as it makes sense *economically*. Cross tabulation with *interest* in specific topics also shows that students would like to participate more in alternative energy, but perhaps the *economics* don't work out quick enough for them to justify implementing those technologies.

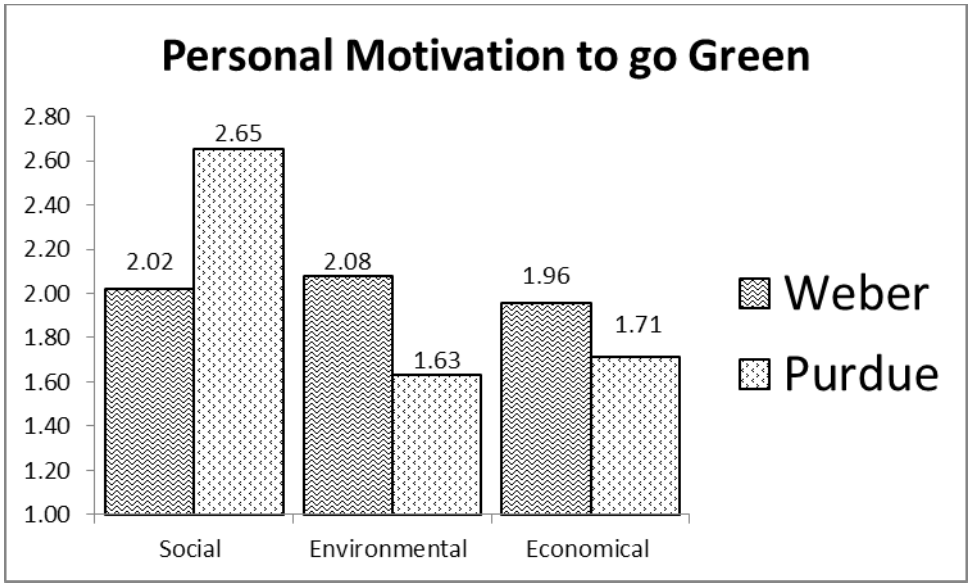


Figure 5.19 Personal Motivations to go Green comparison

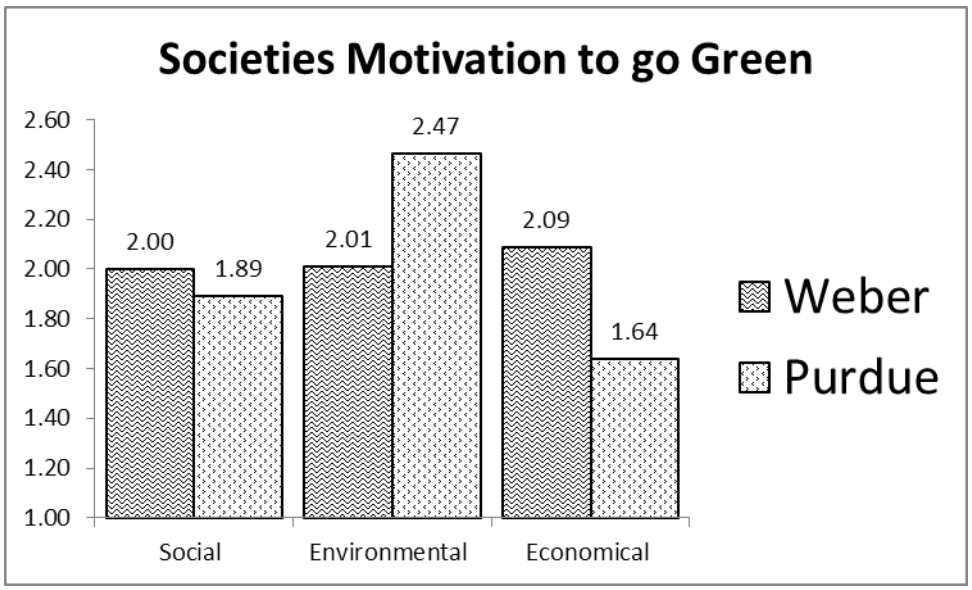


Figure 5.20 Societal Motivations to go Green comparison

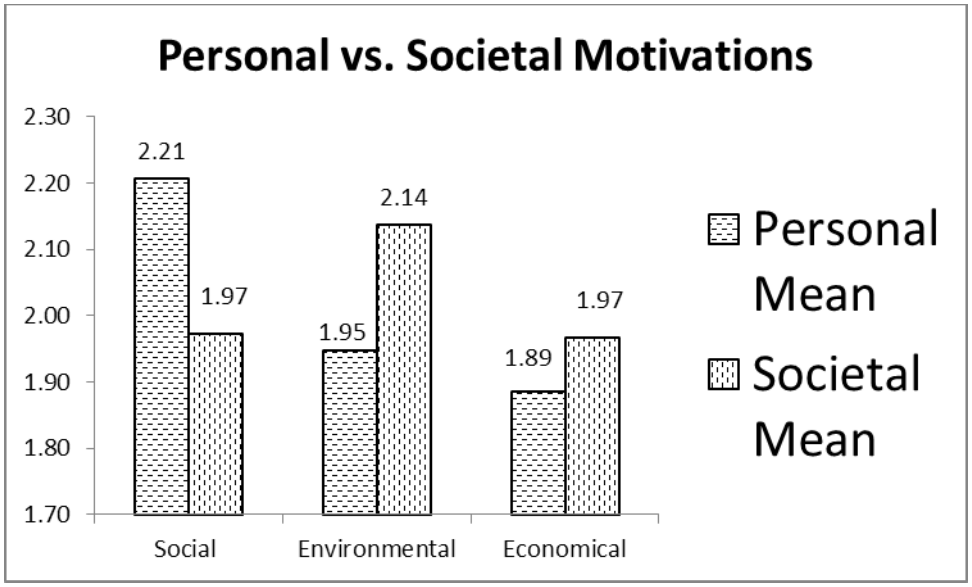


Figure 5.21 Combined Personal vs. Societal Motivations to go Green

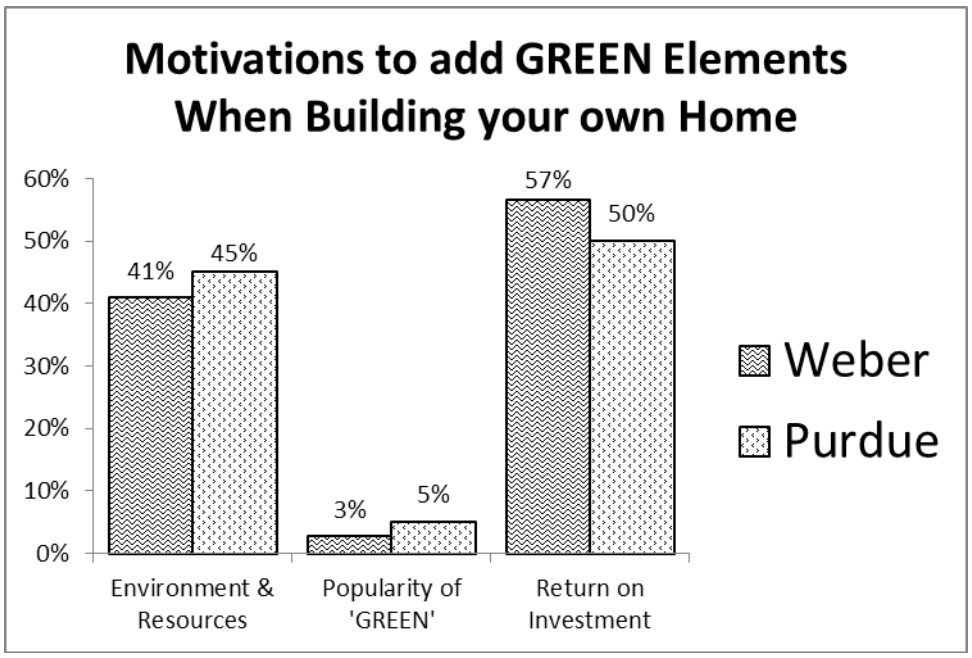


Figure 5.22 Motivations to go Green when money is involved comparison

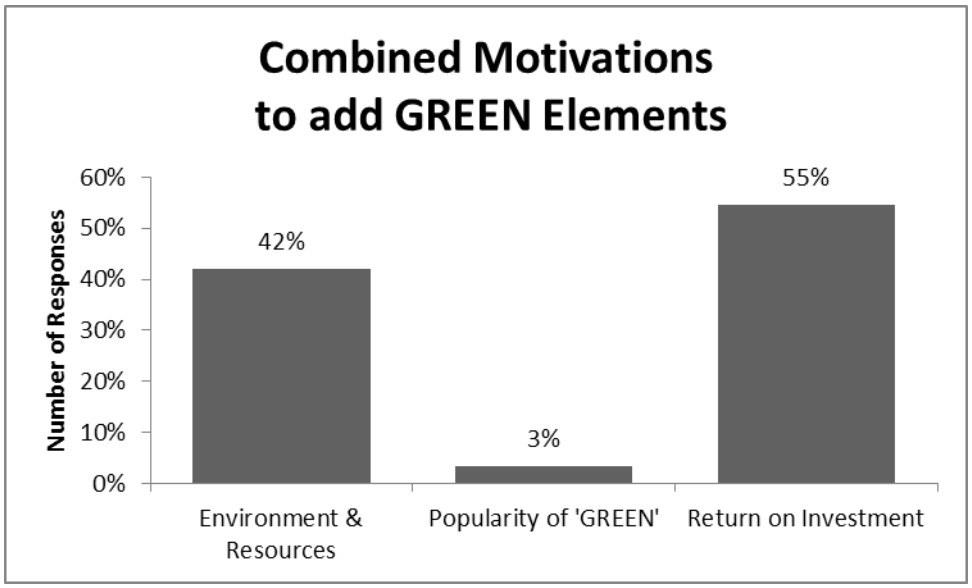


Figure 5.23 Motivations to go Green when money is involved combined

When asked "If you were considering building or buying a home, which of the following would most likely motivate you to incorporate Green Building principles into your home?", students overwhelmingly chose a return on investment or efficiency of the products they would be incorporating. This leads me to believe that when the wallet is involved, although the *environmental* aspects are important to students, the larger majority of them would be motivated *economically*.

If we cross tabulate the number of students who chose *economical* as their primary motivation and compare that with this question we get the following data. In the question about buying a home it was restricted to only allow students to select one motivation only and not rank them. The mean has been eliminated and a comparison is only shown between what students had reported as the primary or first choice of their personal motivation. Comparing the two data sources of asking primarily the same question in two different ways renders staggering results. This is further proof that student do not really understand Green Building and everything that it encompasses. The motivation to go green cannot vary this much if there were a more broad and solid *understanding* of the concepts that drive the market of green.

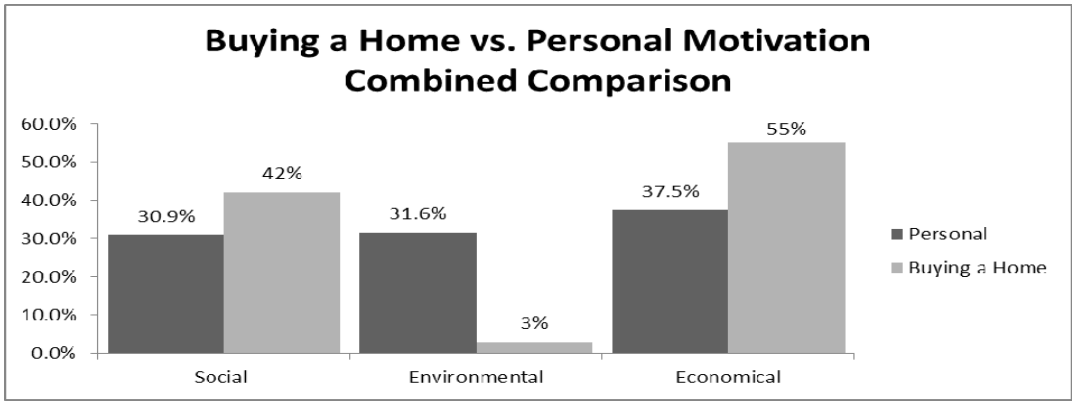


Figure 5.24 Buying a Home vs. Personal Motivation

The last comparison examines what students perceive as an acceptable return on investment time when implementing green products or features into a home. The payback periods selected prove that little is *known* about the realistic payback periods to be expected when implanting green features into a home. It can be argued that this question is statistically irrelevant due to the broad spectrum of items that can be implemented in a home. Green Building features can be as simple as more insulation that has a relatively quick payback period, or as complex as photovoltaics which have up to 10-15 years of payback depending on the location where you live. It appears that Purdue students have a greater or more realistic *understanding* of ROI payback periods. The averaged results prove to be more pertinent to manufacturer of products. If they want students to invest in their products, they should make the payback period fall between 4-5 years.

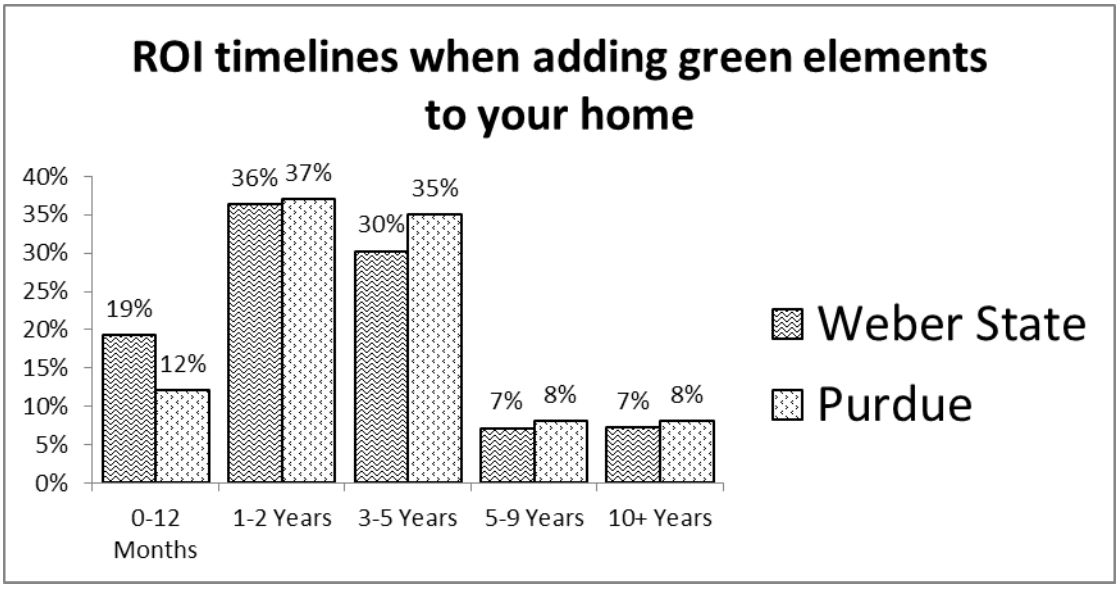


Figure 5.25 ROI timelines when adding green elements to your home

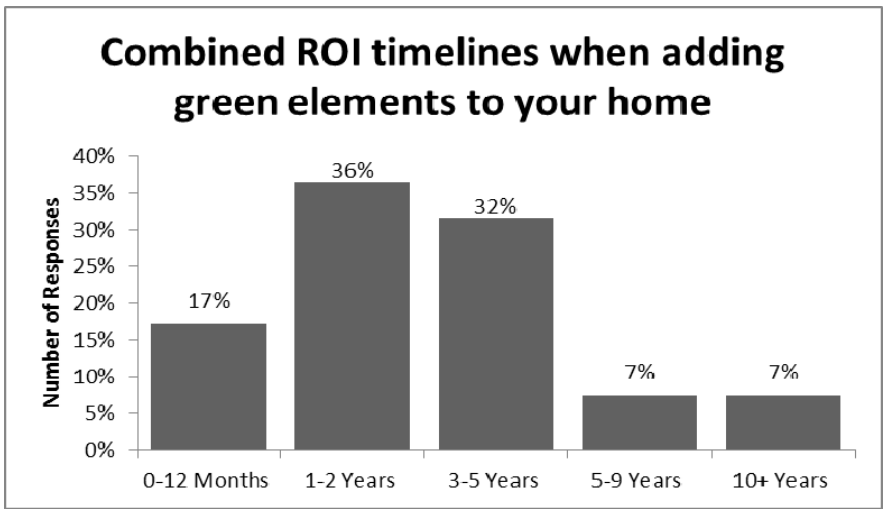


Figure 5.26 ROI timelines when adding green elements to your home

5.2 Summary

The data analysis provided above is not in any way meant to be exhaustive. There are several spin-offs to this study that could be done and have been alluded to throughout the narrative of data analysis done in this chapter. The data seems to indicate that students are very *interested* in learning more about sustainability and Green Building but lack the structured environment where this education can be provided. It is my hope that the data revealed in this study has validated the need to develop a curriculum that teaches sustainability and Green Building concepts to a much broader audience than is currently the case. The data has also suggested that we are not doing a sufficient job in teaching design, construction, and engineering students about ways to green the built environment. The literature review coupled with the research just presented is aimed at encouraging discussion about ways colleges and universities across the country can address the need and desires of their students to get more education on sustainability and Green Building.

CHAPTER 6. SUMMARY, OUTCOMES, AND IMPLICATIONS

This study has discovered the *knowledge* and or *knowledge* gaps that exist within the student population at two universities in the U.S. in regards to sustainability and Green Building. It has also been determined that there exists sufficient *interest* in creating a general elective course offered to students across all colleges and disciplines. It is the opinion of the author that a course concentrating on sustainability and Green Building in the built environment, specifically homes, would be popular among students of all majors and disciplines across campus.

It is beyond the scope of this study to determine in which general education requirement this particular course best fits, but it is the suggestion and opinion of the author that it fits best within either the physical or life sciences requirement. The course title would best be described as "How to Green your Future or Existing Home". The data found in Chapter 5 of this study has shown that such a course would be in high demand and would stir lively discussion.

In order to address each of the eight research question and four objectives of this study, a good cross section of the student population at each university needed to be surveyed. The goal for this study was to get at a minimum 1,000 respondents to participate. The final number was approximately 1,460 students, representing all colleges and disciplines. This chapter will outline the completed objectives and answers to all research questions as outlined in Chapter 1.

6.1. Summary of this Study

The primary objective of this study was to determine what students across all majors and disciplines *know* and want to *know* more about sustainability and Green Building in the built environment. This would allow curriculum to be developed that was multi-disciplinary to meet the needs of general education requirements. This was accomplished by analyzing a good cross section of the student population across all majors and disciplines to allow broad themes to be established of what students already knew vs. what they wanted to *know* more about.

The second objective of developing suggestions for what the curriculum should contain was done by comparing current *knowledge* or *familiarity* with *interest* levels. The comparison allowed a differential to be extracted that showed which topics should be covered in greater detail to narrow the *knowledge* gap that existed. Figure 6.1 is a graphical representation of this information. At the far right side of the graph, the mean *familiarity* of all students that participated in the study was 2.50 and the *interest* mean was 2.88. The average differential mean was .38 which shows that there is a significant *knowledge* gap compared to the *interest* level.

The thirds objective of creating a pool of data where upon further studies could be done has also be established. There are several opportunities for a more in depth look or study to be done to determine where students' perceptions and opinions are coming from. The data can be analyzed to determine national trends that exist regarding how well sustainability is currently being taught in our educational system. The data points out specific areas where improvements can and should be made, specifically in the areas of design and construction.

The fourth objective has been accomplished in providing evidence that sustainability and Green Building is on the minds of students, and they are *interested* in learning more about its implication in the built environments. This is shown in the attitudes towards and concern with topics found within Green Building and sustainability. Research questions 1-5 on what students understand, their attitudes towards or concern with, what actions they are prepared to take or have taken, how they rank their personal vs. societal motivation to go green, and whether Green Building is worth it, and when is an acceptable ROI for implement green features are directly addressed with specific question with the results being covered in Chapter 5. Questions 6-8 are summarized in section 6.2 as they relate to the implications for teaching sustainability and Green Building in the built environment. This section gives an outlines specific topics that should be covered based upon *knowledge*, *understanding*, *familiarity* and *interest*.

6.2. Implications for Teaching

Using figure 6.1, a side-by-side analysis of what students reported as their current *knowledge* on each topic compared to their *interest* in learning more about the topic, can be facilitated. Figure 6.1 shows which topics should be covered and how much time should be spent on each topic. For example, appliance efficiency is not a topic that has a significant enough discrepancy to merit its discussion in the curriculum and would not be a suggested topic to discuss. Other topics of little differentiation are water conservation and lighting efficiency. This may be due to the high level of *knowledge* already existing in students, or simply that students are sufficiently informed about the topic. Whereas NAHB Certified Green Built Homes, LEED for homes and solar hot water are all topics that would merit substantial time commitments in the course. This chart could be used to determine which topics get the most

emphasis, and how to schedule the topics of discussion most efficiently to address the *interest* levels of students, while still touching on all topics, since all had higher *interest* levels than *knowledge* or *familiarity*.

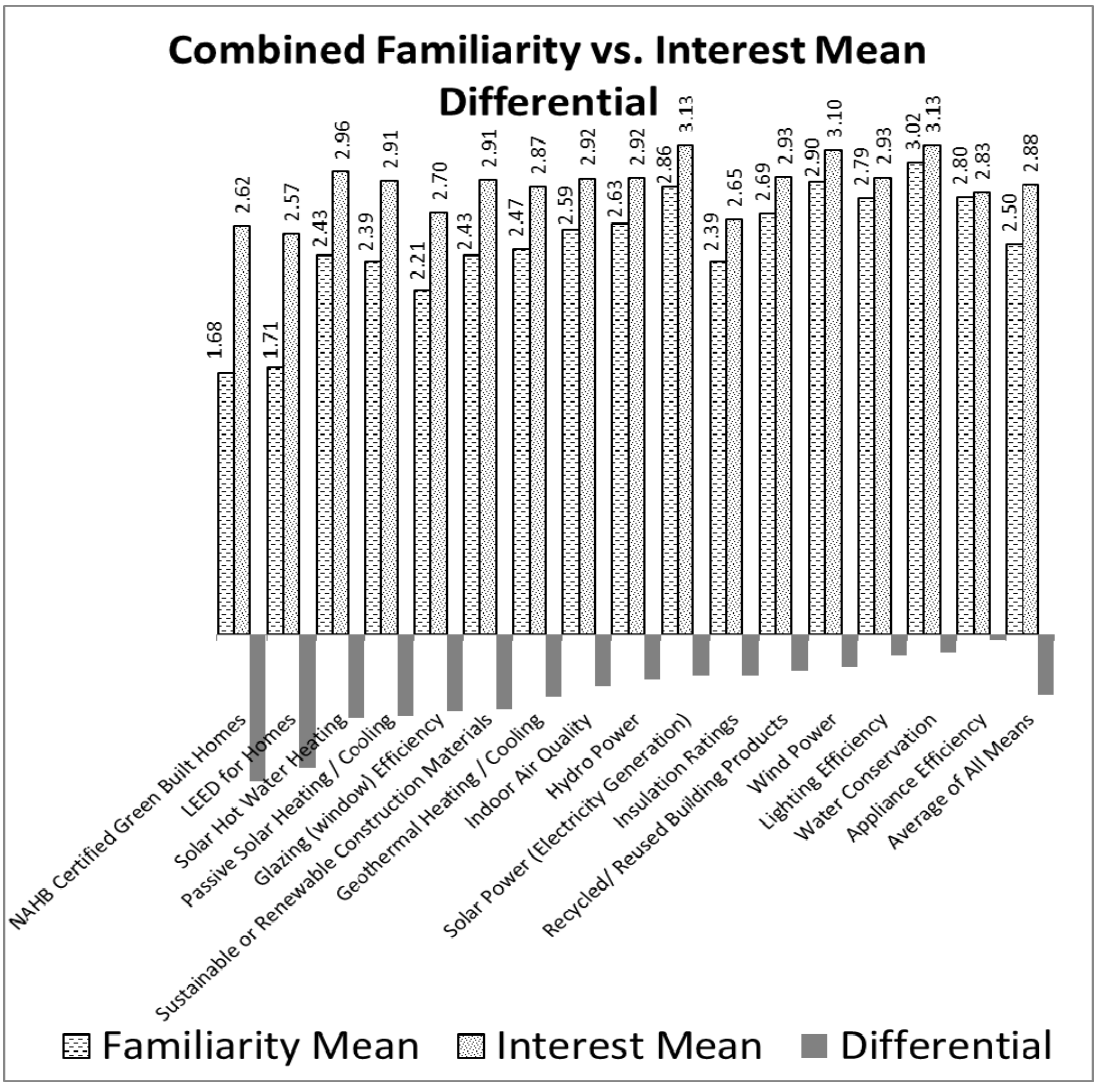


Figure 6.1 Combined *Familiarity* vs. *Interest* Mean Differential

This study uncovered areas in which improvements can be made to existing curricula that are affected by sustainability and Green Building such as economics, geography, and

science. The study proves that students are *interested* in learning more about alternative energy sources and how economics are closely tied to how fast this Green Building movement will continue to grow. This study also proves that students have great aptitude and attitude for sustainability and Green Building topics of discussion.

6.3. Recommendations for Future Studies

Throughout the analysis of data, there is much more potential to delve deeper into the outcomes of this study. Items of particular *interest* are;

- What really motivates someone to go green or implement green into their homes?
- What is a realistic but acceptable payback period for investing in green products?
- Would students' perspectives and opinions change after taking a class as proposed?

6.4. Summary

My perspective is that the green movement is either going to pass colleges and universities by or we are going to help move it forward. All industries face the inevitable advances in technology that change the way they do business. Right now the construction and design industries are faced with this challenge. With the popularity of going green so high, and

the demand to be more *environmentally* friendly, we have no choice but to embrace it and move forward. Continuous improvement is the only way to have long term success. The building industry will continue to make vast strides of improvement and we will see less dependence on oil for energy and allow the general public to more self-sufficient. Green Building is an exciting topic to discuss because it is ever evolving.

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Appendix A. Purdue University Survey

PURDUE
UNIVERSITY

Informed Consent

You have been selected to be part of a research study to determine what the general student population knows and would like to know about "Green" or Sustainable building.

You were selected to participate in this study because of your affiliation with Weber State University in Utah, or Purdue University in Indiana. The results will allow cross geographical analysis to be completed.

The survey will take 5-10 minutes to complete. All completed surveys will be included in computed data comparisons.

This survey is completely confidential; it is administered through a third party survey service. None of the results are connected in any way to any email address.

Participation in this survey is voluntary and you will not be compensated for completing it.
You must be 18 years of age, or older, to participate.

If you have any questions or concerns, you may contact the principle investigator or co-principle investigor:

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BY SELECTING, I CERTIFY THAT:

- ☐ I have read and understand the above informed consent information. I understand that I will not be compensated for completing this survey, and that my participation is voluntary.
- ☐ I am 18 years of age, or older.

Figure A.1 Informed Consent Form for Purdue Survey

What is your Affiliation with your School?

- Freshman
- Sophomore
- Junior
- Senior
- Graduate Student
- Faculty/ Staff

What is your age?

- 18-20
- 21-25
- 26-30
- 31-40
- 41-50
- 50+

What is your major emphasis of study?

- Applied Science and Technology
- Arts and Humanities
- Business and Economics
- Education
- Engineering
- Health Professions
- Science
- Social and Behavioral Sciences
- Other Please Specify

Figure A.2 Demographic background for Purdue Respondents

How would you rate your knowledge/ understanding of these terms?

	Not at all familiar	Unfamiliar	Familiar	Very Familiar
Green Building	○	○	○	○
Sustainability	○	○	○	○

Please indicate your familiarity with and interest in learning about the following:

	FAMILIARITY				INTEREST			
	High	Medium	Low	None	High	Medium	Low	None
Passive Solar Heating / Cooling	○	○	○	○	○	○	○	○
Geothermal Heating / Cooling	○	○	○	○	○	○	○	○
Indoor Air Quality	○	○	○	○	○	○	○	○
Glazing (window) Efficiency	○	○	○	○	○	○	○	○
Appliance Efficiency	○	○	○	○	○	○	○	○
Insulation Ratings	○	○	○	○	○	○	○	○
Solar Hot Water Heating	○	○	○	○	○	○	○	○
Solar Power (Electricity Generation)	○	○	○	○	○	○	○	○
Sustainable or Renewable Construction Materials	○	○	○	○	○	○	○	○
Recycled/ Reused Building Products	○	○	○	○	○	○	○	○
Water Conservation	○	○	○	○	○	○	○	○
Wind Power	○	○	○	○	○	○	○	○
Hydro Power	○	○	○	○	○	○	○	○
Lighting Efficiency	○	○	○	○	○	○	○	○
NAHB Certified Green Built Homes	○	○	○	○	○	○	○	○
LEED for Homes	○	○	○	○	○	○	○	○

Figure A.3 Familiarity and *Interest* in Sustainability and Green Building topics

In what fields have you had previous formal education where sustainability was addressed? (Select all that apply)

- ☐ Geography
- ☐ Biology
- ☐ Environmental Science
- ☐ Economics
- ☐ Design
- ☐ Construction
- ☐ None

Have you done any of the following? (Select all that apply)

- ☐ Educated Yourself or Trained Others about Green Building/ Sustainability Practices
- ☐ Political Action such as Writing Letters to Senators, Protests, Campaigning, Boycotts, Membership in Greenpeace (or other), etc.
- ☐ Used Alternative Energy Sources (Solar, Wind, Hydro)
- ☐ Researched, Designed or Built Green Structures/Technologies Professionally
- ☐ Starting Energy-Saving Habits
- ☐ Participated in Nature Conservation (Planting Trees, Trash Cleanup, etc.)
- ☐ Recycling, Reducing Waste, Reuse, etc.
- ☐ Changing Shopping Habits to Support Green Businesses
- ☐ Used Alternate Transportation Methods (Mass Transit, Bike)

Figure A.4 Prior Experiences and Education with Sustainability and Green Building

What would be your interest level in taking a course about ways to "Green" your existing or future home?

- 1. NO INTEREST
- 2. SLIGHT INTEREST
- 3. MODERATE INTEREST
- 4. HIGH INTEREST
- 5. EXTREME INTEREST

How likely would you be to take a course about the following "Green Building" topics, offered as a general elective and fulfilling a breadth requirement?

	Very Unlikely	Unlikely	Likely	Very Likely
A Class about steps to Greening Your Home				
Environmental Appreciation				
Environmental Issues & Economic Policy				

What is your Opinion of Green Building in General?

- I think it is a waste of time and effort.
- It doesn't bother me.
- I think it's OK for others to do it.
- I think it's a good thing.
- I'm a passionate advocate.

Write up to 4 keywords (not a sentence) conveying your personal understanding of "green" building or sustainability. [EXAMPLE: Peanut Butter: creamy | sandwich | brown | sweet]

Figure A.5 Opinion and *interest* in learning more about Sustainability & Green Building

Rank **YOUR** Personal Motivation to be more "Green".
(Order **YOUR** preference from 1-3 by dragging the selections up or down)

Social (Peer Influence or Popularity of Green)

Environmental (Save World)

Economical (Save Money)

Rank what you Percieve Motivates **SOCIETY** to be more "Green".
(Order **SOCIETIES** preference from 1-3 by dragging the selections up or down)

Social (Peer Influence or Popularity of Green)

Environmental (Save World)

Economical (Save Money)

If you were considering building or buying a home, which of the following would most likely motivate you to incorporate Green Building principles into your own house?

- Concern for the Environment & Natural Resources
- Going with the flow - Popularity of "Green"
- Getting a Return on an Investment

Figure A.6 Motivations behind Sustainability and Green Building movement

What are you prepared to do in your personal lifestyle in regards to "green" building and sustainability? (Select all that you would be willing to do)

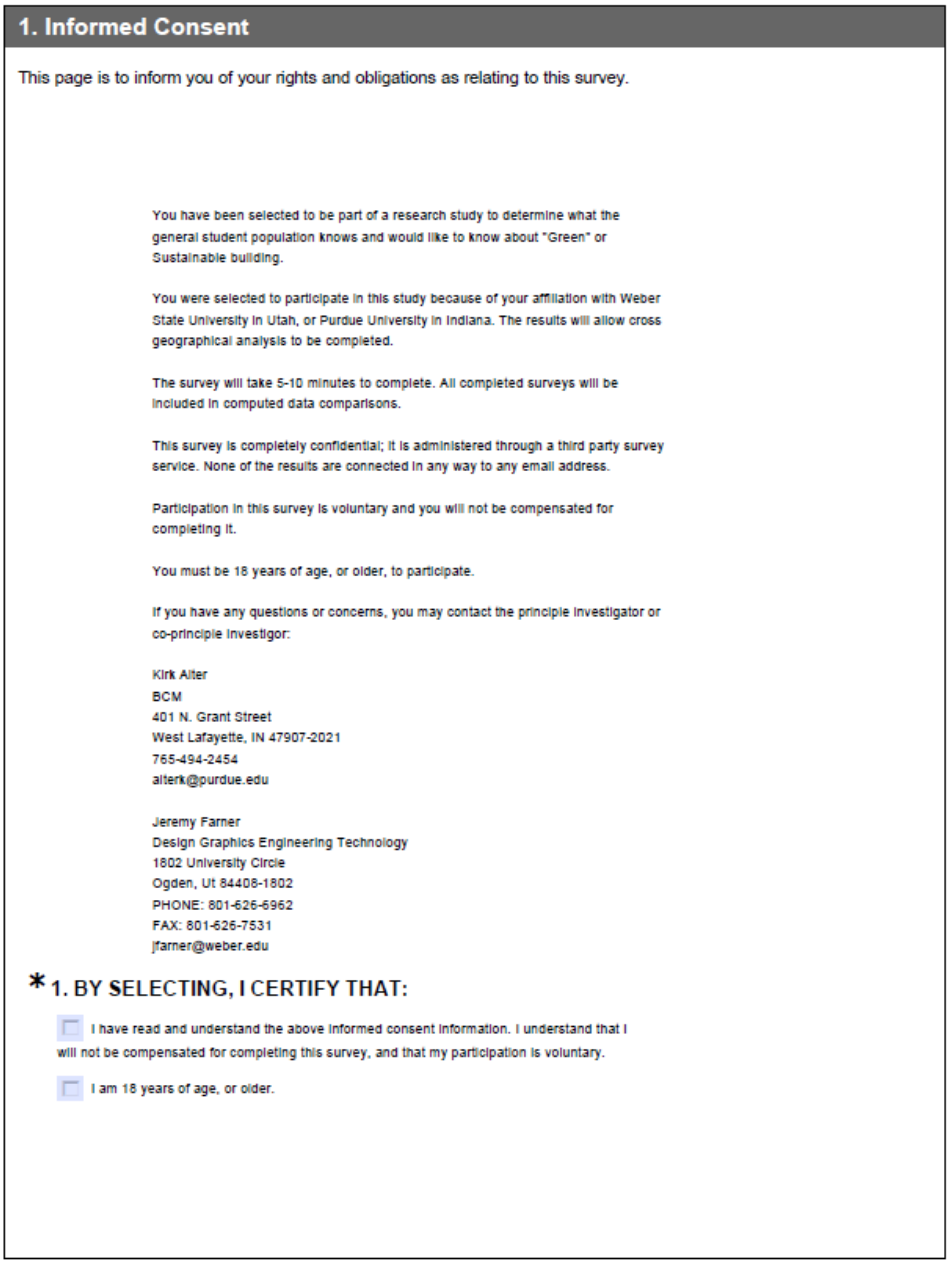
- [ ] Consumer Change (Buy more Green Building Products i.e. Flooring, etc.)
- [ ] Recycling
- [ ] Energy and/or Water Efficient Appliances
- [ ] Education (Learn and be Aware of Options by Taking a Class at University Level)
- [ ] Alternative Energy Use (Solar, Wind, Hydro, Clean Energy)
- [ ] Political Actions (Advocate, Campaign, Vote, or Protest)
- [ ] Nature Conservation/Volunteering (Clean Parks/Rivers, Avoid Littering, Plant Trees)

What is the time limit for you to start to see a return on investment when adding green elements to your home? (When the money saved exceeds the cost of the upgraded element ie. energy efficient appliances)

- ( ) 0-12 Months
- ( ) 1-2 Years
- ( ) 3-5 Years
- ( ) 5-9 Years
- ( ) 10+ Years

Figure A.7 Participation in/ Realistic *understanding* of Sustainability & Green Building

Appendix B. Weber State University



1. Informed Consent

This page is to inform you of your rights and obligations as relating to this survey.

You have been selected to be part of a research study to determine what the general student population knows and would like to know about "Green" or Sustainable building.

You were selected to participate in this study because of your affiliation with Weber State University in Utah, or Purdue University in Indiana. The results will allow cross geographical analysis to be completed.

The survey will take 5-10 minutes to complete. All completed surveys will be included in computed data comparisons.

This survey is completely confidential; it is administered through a third party survey service. None of the results are connected in any way to any email address.

Participation in this survey is voluntary and you will not be compensated for completing it.

You must be 18 years of age, or older, to participate.

If you have any questions or concerns, you may contact the principle investigator or co-principle investigor:

Kirk Alter
BCM
401 N. Grant Street
West Lafayette, IN 47907-2021
765-494-2454
alterk@purdue.edu

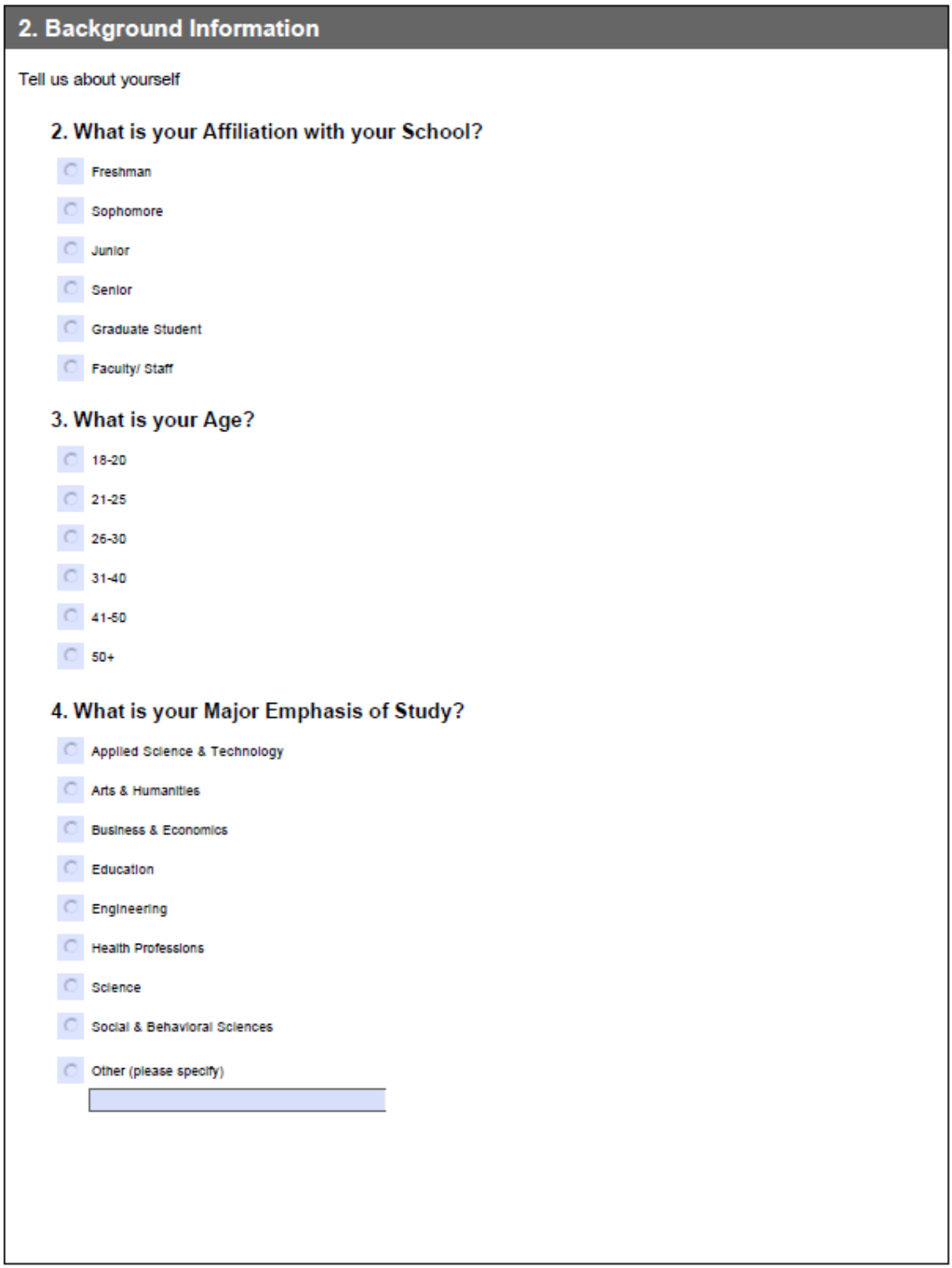
Jeremy Farner
Design Graphics Engineering Technology
1802 University Circle
Ogden, Ut 84408-1802
PHONE: 801-626-6962
FAX: 801-626-7531
jfarner@weber.edu

*** 1. BY SELECTING, I CERTIFY THAT:**

☐ I have read and understand the above informed consent information. I understand that I will not be compensated for completing this survey, and that my participation is voluntary.

☐ I am 18 years of age, or older.

Figure B.1 Informed Consent Form for WSU Survey



2. Background Information

Tell us about yourself

2. What is your Affiliation with your School?

- Freshman
- Sophomore
- Junior
- Senior
- Graduate Student
- Faculty/ Staff

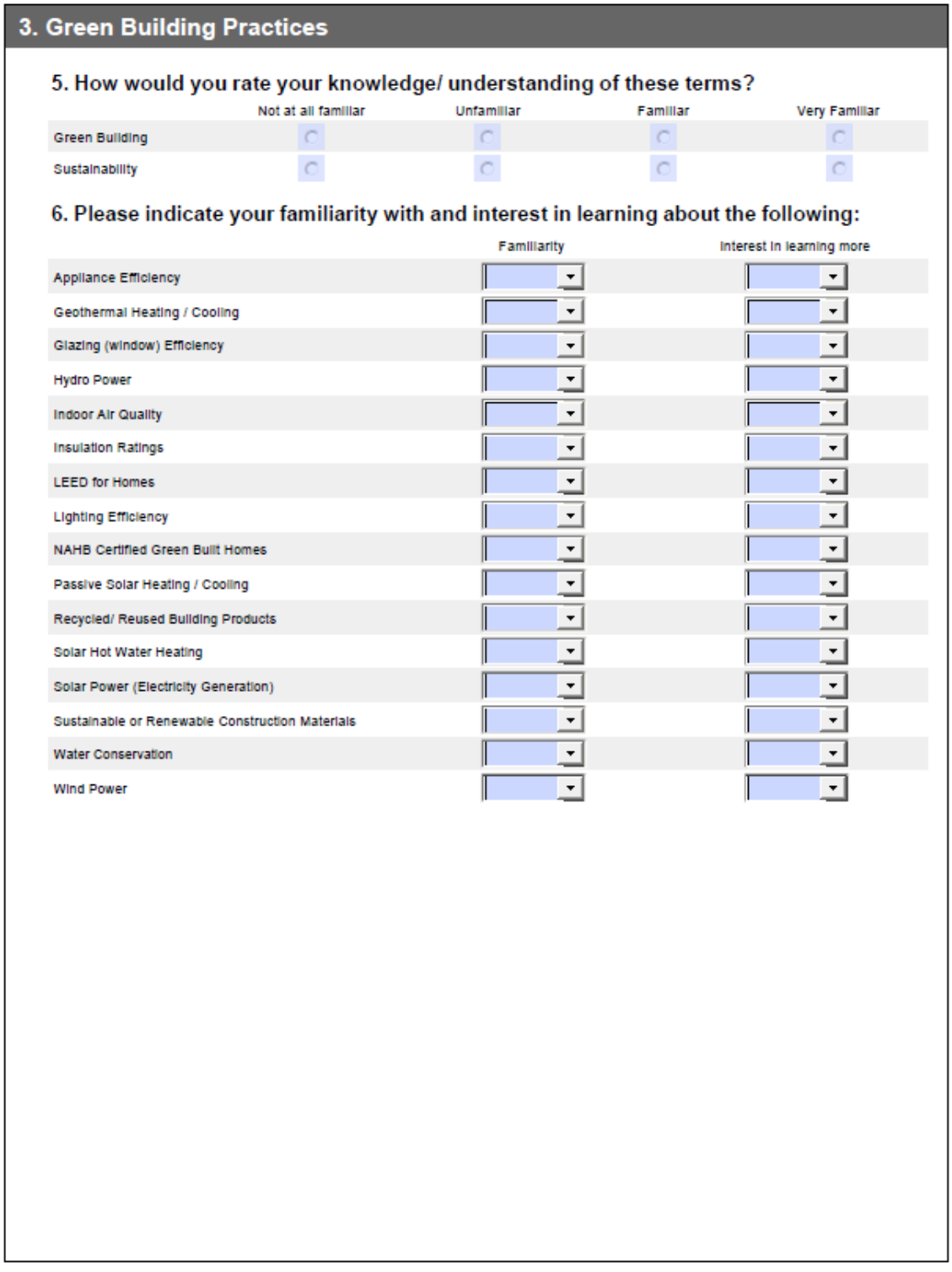
3. What is your Age?

- 18-20
- 21-25
- 26-30
- 31-40
- 41-50
- 50+

4. What is your Major Emphasis of Study?

- Applied Science & Technology
- Arts & Humanities
- Business & Economics
- Education
- Engineering
- Health Professions
- Science
- Social & Behavioral Sciences
- Other (please specify)

Figure B.2 Demographic background for WSU Respondents



3. Green Building Practices

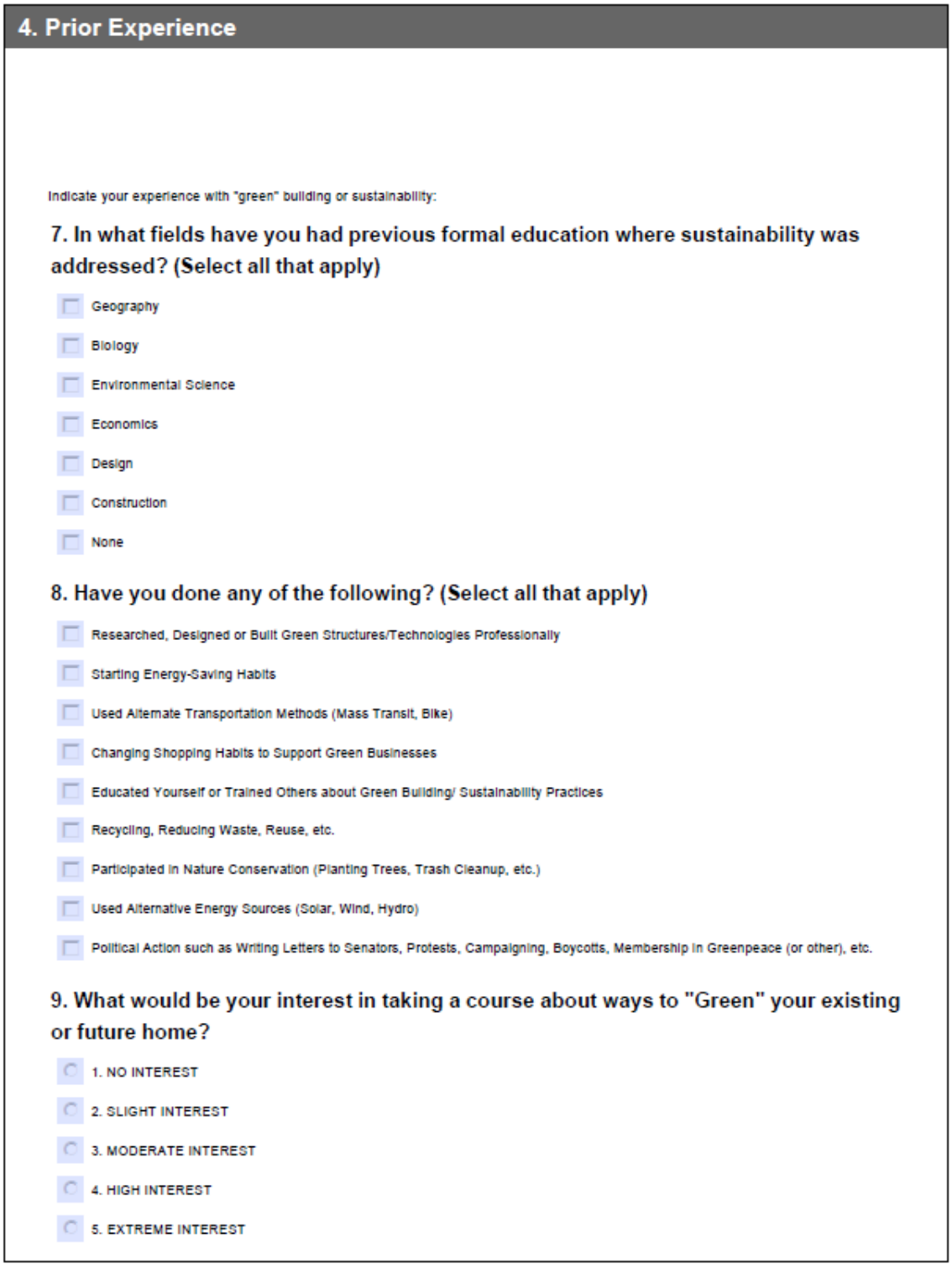
5. How would you rate your knowledge/ understanding of these terms?

	Not at all familiar	Unfamiliar	Familiar	Very Familiar
Green Building	○	○	○	○
Sustainability	○	○	○	○

6. Please indicate your familiarity with and interest in learning about the following:

	Familiarity	Interest in learning more
Appliance Efficiency		
Geothermal Heating / Cooling		
Glazing (window) Efficiency		
Hydro Power		
Indoor Air Quality		
Insulation Ratings		
LEED for Homes		
Lighting Efficiency		
NAHB Certified Green Built Homes		
Passive Solar Heating / Cooling		
Recycled/ Reused Building Products		
Solar Hot Water Heating		
Solar Power (Electricity Generation)		
Sustainable or Renewable Construction Materials		
Water Conservation		
Wind Power		

Figure B.3 Familiarity and *Interest* in Sustainability and Green Building topics



4. Prior Experience

Indicate your experience with "green" building or sustainability:

7. In what fields have you had previous formal education where sustainability was addressed? (Select all that apply)

- ☐ Geography
- ☐ Biology
- ☐ Environmental Science
- ☐ Economics
- ☐ Design
- ☐ Construction
- ☐ None

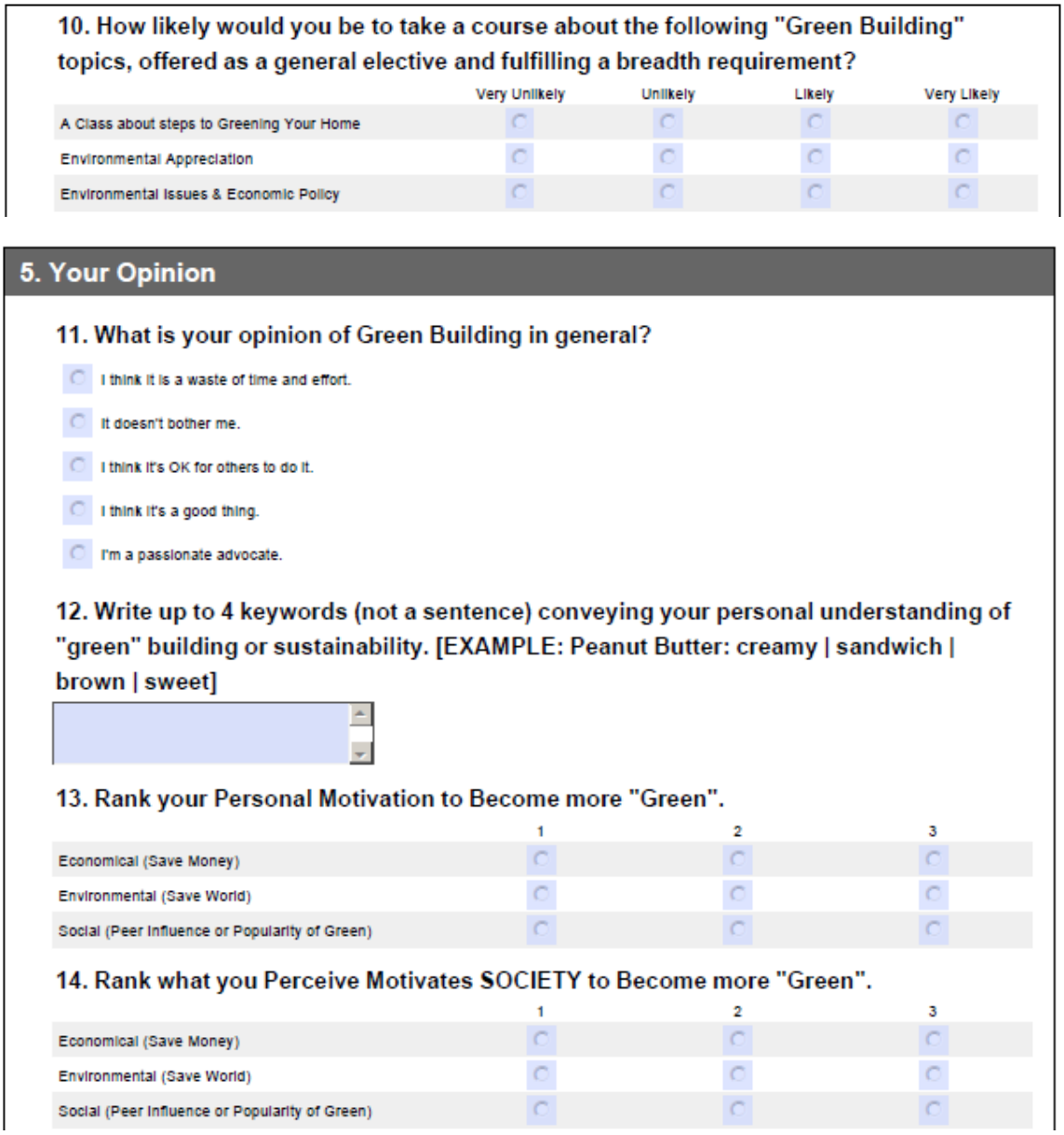
8. Have you done any of the following? (Select all that apply)

- ☐ Researched, Designed or Built Green Structures/Technologies Professionally
- ☐ Starting Energy-Saving Habits
- ☐ Used Alternate Transportation Methods (Mass Transit, Bike)
- ☐ Changing Shopping Habits to Support Green Businesses
- ☐ Educated Yourself or Trained Others about Green Building/ Sustainability Practices
- ☐ Recycling, Reducing Waste, Reuse, etc.
- ☐ Participated in Nature Conservation (Planting Trees, Trash Cleanup, etc.)
- ☐ Used Alternative Energy Sources (Solar, Wind, Hydro)
- ☐ Political Action such as Writing Letters to Senators, Protests, Campaigning, Boycotts, Membership in Greenpeace (or other), etc.

9. What would be your interest in taking a course about ways to "Green" your existing or future home?

- ○ 1. NO INTEREST
- ○ 2. SLIGHT INTEREST
- ○ 3. MODERATE INTEREST
- ○ 4. HIGH INTEREST
- ○ 5. EXTREME INTEREST

Figure B.4 Prior Experiences and Education with Sustainability and Green Building



10. How likely would you be to take a course about the following "Green Building" topics, offered as a general elective and fulfilling a breadth requirement?

	Very Unlikely	Unlikely	Likely	Very Likely
A Class about steps to Greening Your Home	○	○	○	○
Environmental Appreciation	○	○	○	○
Environmental Issues & Economic Policy	○	○	○	○

5. Your Opinion

11. What is your opinion of Green Building in general?

- ○ I think it is a waste of time and effort.
- ○ It doesn't bother me.
- ○ I think it's OK for others to do it.
- ○ I think it's a good thing.
- ○ I'm a passionate advocate.

12. Write up to 4 keywords (not a sentence) conveying your personal understanding of "green" building or sustainability. [EXAMPLE: Peanut Butter: creamy | sandwich | brown | sweet]

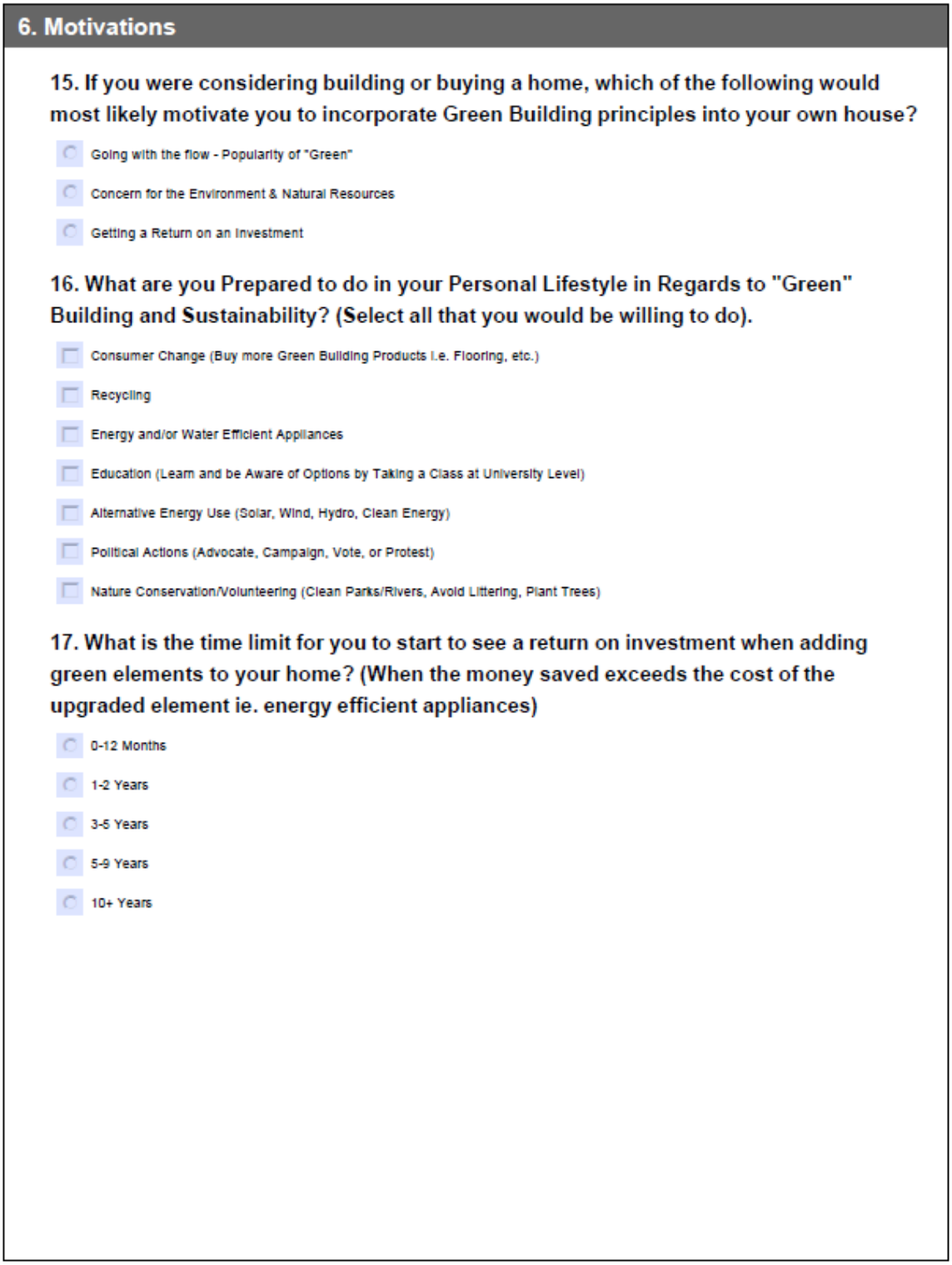
13. Rank your Personal Motivation to Become more "Green".

	1	2	3
Economical (Save Money)	○	○	○
Environmental (Save World)	○	○	○
Social (Peer Influence or Popularity of Green)	○	○	○

14. Rank what you Perceive Motivates SOCIETY to Become more "Green".

	1	2	3
Economical (Save Money)	○	○	○
Environmental (Save World)	○	○	○
Social (Peer Influence or Popularity of Green)	○	○	○

Figure B.5 Opinion and *interest* in learning more about Sustainability & Green Building



6. Motivations

15. If you were considering building or buying a home, which of the following would most likely motivate you to incorporate Green Building principles into your own house?

- ○ Going with the flow - Popularity of "Green"
- ○ Concern for the Environment & Natural Resources
- ○ Getting a Return on an Investment

16. What are you Prepared to do in your Personal Lifestyle in Regards to "Green" Building and Sustainability? (Select all that you would be willing to do).

- ☐ Consumer Change (Buy more Green Building Products i.e. Flooring, etc.)
- ☐ Recycling
- ☐ Energy and/or Water Efficient Appliances
- ☐ Education (Learn and be Aware of Options by Taking a Class at University Level)
- ☐ Alternative Energy Use (Solar, Wind, Hydro, Clean Energy)
- ☐ Political Actions (Advocate, Campaign, Vote, or Protest)
- ☐ Nature Conservation/Volunteering (Clean Parks/Rivers, Avoid Littering, Plant Trees)

17. What is the time limit for you to start to see a return on investment when adding green elements to your home? (When the money saved exceeds the cost of the upgraded element ie. energy efficient appliances)

- ○ 0-12 Months
- ○ 1-2 Years
- ○ 3-5 Years
- ○ 5-9 Years
- ○ 10+ Years

Figure B.6 Motivations behind Sustainability and Green Building movement

Participation in/ Realistic *understanding* of Sustainability & Green Building

Appendix C. Purdue University IRB Approval Letter

PURDUE
UNIVERSITY

HUMAN RESEARCH PROTECTION PROGRAM
INSTITUTIONAL REVIEW BOARDS

To:	KIRK ALTER KNOY 433
From:	RICHARD MATTES, Chair Social Science IRB
Date:	11/03/2010
Committee Action:	**Exemption Granted**
IRB Action Date:	10/05/2010
IRB Protocol #:	1009009693
Study Title:	Sustainable Green Building Perceptions & Educational Needs

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

If you wish to revise or amend the protocol, please submit a revision request to the IRB for consideration. Please contact our office if you have any questions.

We wish you good luck with your work. Please retain copy of this letter for your records.

Below is a list of best practices that you should be aware of and keep in mind when conducting your research.

Category 1

- Written permission from preschools, primary and/or secondary schools should be obtained prior to the investigator engaging in research, such as recruitment and conducting research procedures. If the written permission was not submitted with the protocol at the time of IRB review (e.g., the school would not issue the letter without proof of IRB approval), the investigator must submit the written permission to the IRB office immediately upon receipt from the school. This is a Human Research Protection Program requirement.

Categories 2 and 3

- Surveys and data collection instruments should note that only participants 18 years of age and over are eligible to participate in the research, state that participation is voluntary and that any questions may be skipped, and include the investigator's name and contact information.
- Investigators should explain to participants the amount of time required to participate. Additionally, they should explain to participants how confidentiality will be maintained or if it will not be maintained.
- When conducting focus group research, investigators cannot guarantee that all participants in the focus group will maintain the confidentiality of other group participants. The investigator should make participants aware of this potential for breach of confidentiality.
- Written permission from businesses, preschools, primary and/or secondary schools should be obtained prior to the investigator engaging in research, such as recruitment and conducting research procedures. If the written

Figure C.1 Purdue IRB Approval Letter page 1 of 2

permission was not submitted with the protocol at the time of IRB review (e.g., the school would not issue the letter without proof of IRB approval), the investigator must submit the written permission to the IRB office immediately upon receipt from the school. This is a Human Research Protection Program requirement.

Category 6

- Surveys and data collection instruments should note that participation is voluntary.
- Surveys and data collection instruments should note that participants may skip any questions.
- When taste testing foods which are highly allergenic (e.g., peanuts, milk, etc.) investigators should disclose the possibility of a reaction to potential subjects.

General

- To recruit from Purdue University classrooms, the instructor and all others associated with conduct of the course (e.g., teaching assistants) must not be present during announcement of the research opportunity or any recruitment activity. This may be accomplished by announcing, in advance, that class will either start later than usual or end earlier than usual so this activity may occur. It should be emphasized that attendance at the announcement and recruitment are voluntary and the students attendance and enrollment decision will not be known by those administering the course.
- When conducting human subjects research at non-Purdue colleges and universities, investigators are urged to contact that institution#s IRB to determine requirements for conducting research at that institution.
- When conducting human subjects research in places of business, investigators must obtain written permission from an appropriate authority from the business prior to engaging in research activities such as recruitment or conducting study procedures.

Ernest C. Young Hall, 10th Floor · 155 S. Grant St. · West Lafayette, IN 47907-2114 · (765) 494-5942 · Fax: (765) 494-9911

Figure C.2 Purdue IRB Approval Letter page 2 of 2

Appendix D. Weber State University IRB approval Letter



WEBER STATE UNIVERSITY

DEPARTMENT OF PSYCHOLOGY

October 17, 2009

Jeremy Farner
Weber State University
Ogden, UT 84408

Dear Jeremy:

Your project "Educational needs and desires of students and industry professionals " has received an "exempt" review and is approved.

We wish you good luck with your project and remind you that any anticipated changes to the project and approved procedures must be submitted to the IRB prior to implementation. Any unanticipated problems that arise during any stage of the project require a written report to the IRB and possible suspension of the project.

A final copy of your application will remain on file with the IRB records. If you need further assistance or have any questions, call me at x6812 or e-mail me at tkay@weber.edu.

Sincerely,

Theresa Kay

Theresa Kay
Chair
Institutional Review Board

DEPARTMENT OF PSYCHOLOGY
WEBER STATE UNIVERSITY ▯ 1202 UNIVERSITY CIRCLE ▯ OGDEN UT 84408-1202
(801) 626-6247

Figure D.1 Weber State University IRB Approval Letter

Appendix E. Example Email Invitation

You have been selected to be part of a research study to determine what the general student population *knows* and would like to *know* about "Green" or Sustainable building.
You were selected to participate in this study because of your affiliation with Weber State University in Utah, or Purdue University in Indiana. The results will allow cross geographical analysis to be completed.
The survey will take 5-10 minutes to complete. All completed surveys will be included in computed data comparisons.
This survey is completely confidential; it is administered through a third party survey service. None of the results are connected in any way to any email address.
Participation in this survey is voluntary and you will not be compensated for completing it.
You must be 18 years of age, or older, to participate.
Please click on the link to enter the survey.
https://purdue.qualtrics.com/SE/?SID=SV_cC1cFhbWgiCCYss
If the link does not work, please copy and paste the URL above into your web browser to enter the survey.

If you have any questions or concerns, you may contact the principle investigator or co-principle investigator:

Kirk Alter
BCM
401 N. Grant Street
West Lafayette, IN 47907-2021
765-494-2454
alterk@purdue.edu

Jeremy Farner
MMET
1802 University Circle
Ogden, Ut 84408-1802
801-626-6962
JFARNER@WEBER.EDU