SUSTAINABILITY TOOLKIT: AN EDUCATIONAL TOOL FOR BEHAVIORAL CHANGE STRATEGIES

by

Ambar A. Gardner

Thesis Submitted to the Faculty of the

SCHOOL OF ARCHITECTURE

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

2017

STATEMENT BY AUTHOR

The thesis titled Sustainability Toolkit: An Educational Tool for Behavioral Change Strategies prepared by Ambar A. Gardner has been submitted in partial fulfillment of requirements for a master's degree at the University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that an accurate acknowledgement of the source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: *Ambar A. Gardner*

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Professor, Nader Chalfoun, School of Architecture   May 1, 2016

Dedication

A special thanks to my family and friends who supported me and guided me throughout the years.

Table of Contents

Table of Figures

List of Tables

Abstract

Purpose: There is a worldwide movement towards sustainability. A stepping-stone towards a sustainability conscience population starts in the education of the younger generation. Focusing on improving sustainability education will shift and shape youths' interests and lifestyles into an educated community that will work sustainably. A sustainability conscience community will continue to make moral sustainable decisions in their future endeavors.

The gap between theory and practice of sustainability is substantial. Educational institutions must be the leaders in this subject to mold future generations' incoming leaders into sustainability conscious critical thinkers. Current environmental issues such as climate change, CO_2 Emissions, poverty and so on must impact these educational institutions to make sustainability education a priority in its curriculum. Addressing this problem requires a holistic approach which integrates sustainability education earlier on to grasp further understanding of sustainability actions in higher education and in society.

Sustainability education exists in all levels. Although, sustainability education is much more prominent in higher education institutions as opposed to Elementary, Middle, and High Schools. Consequently, less students are prepared with the desired sustainability knowledge needed in higher education and students' future careers to instill in their disciplines since behavior is achieved through repetitive actions that were not set as a foundation earlier in their education.

Approach: There were two approaches in this research. The first research approach was conducting a survey in 120 students, half of them in secondary education and the other half in higher education. The survey was formatted to analyze three different questions: 1) whether students in high school and higher education knew about sustainability 2) whether students' lifestyle consisted of pro-environmental actions, 3) and whether they learned to perform these actions in secondary education or higher education. The second approach was to create an educational tool to implement sustainability behavioral change strategies in their everyday lifestyles.

Findings: Study found that most students are aware about sustainability. However, most students engage in pro-environmental actions in higher education because they started learning about them in higher education. Therefore, although most secondary education students are aware about sustainability, they aren't engaging in pro-environmental actions. In conclusion, a sustainability toolkit was created based on behavioral change strategies to reduce water usage, CO_2 emissions, energy consumption, and waste output in their school and everyday lifestyles.

Value: The efforts of sustainability in Higher Education have been clear in most recent years, although, there is still much resistance to change, transform and reimagine society and education for sustainability. The future of life and social world on Earth is in jeopardy since poverty, climate change, and lack of peace is occurring worldwide. Sustainability education must respond and act on this challenge subsequently to respect all forms of life and future generations. The mission of the sustainability toolkit is to create a pedagogy to assist educational institutions and communities to develop the skills and knowledge to work sustainably.

Introduction

Education plays a central role in American society. The United States Census Bureau (2015) states that the Unites States population is about 324,696,000 and is projected to increase to 417 million in 2060 (Colby, et al, 2015). Based on the population increase, future generations should become educated on sustainable issues and strategies due to the environmental impact in today's collective consumerist culture. Understanding the implications of climate change can help these generations respond to this crisis accordingly. In order to achieve the common goal of increasing education in the sustainability field, students should be taught this subject extensively and earlier in their education.

1.1 Behavior

Sustainable work is attained through the education of sustainability and applied through pro-sustainability actions. Since habit can be part of any activity, ranging from eating and sleeping to thinking and reacting through reinforcement and repetition, sustainability behaviors must be implemented in students'' daily lifestyle for them to continue these actions as they grow into critical members of society (Habit, 2017). Humans make good and bad decisions all the time which is why it is important to educate the public on sustainability early on to make pro-sustainable actions a habit. Regardless, individuals choose how much education to attain and how to behave in relation to the environment.

Research has reported that knowledge about sustainability does not necessarily translate into action. The gap between awareness and action has been defined as the knowledge-concern action paradox (Lenzen and Cummins, 2011). This paradox is explained by the following factors:

- *The dominance of convenience and financial constraints over moral imperatives*
- *Peer and status pressure to consume resources*
- *The perception that an individual cannot effectively instigate noticeable, lasting change*
- *People's lack of agency and trust in authorities*
- *General shortage of abatement opportunities, such as public transport* (Lenzen and Cummins, 2011)

This gap has supported the claim that environmental concern doesn't always translate to action (Suarez-Varela, et al, 2016). For example, a community that lives in a Favela in Brazil might not be aware of the term sustainability and its benefits as compared to New York City. Education levels between these two communities may vary, although, the poor community in Brazil might engage in sustainability actions more often than those in New York City because of the financial constraints in the area. Poor communities are more likely to re-use materials from an old building, use less resources such as water and energy without being aware of the positive environmental effects that consist of their actions other than its financial benefit. People in New York City might consume more because of the United States' consumerist culture even though they are aware of its environmental effects. Therefore, education and awareness does not necessarily tie to pro-sustainable actions.

It is often misjudged that the more an individual knows about sustainability, the more they would be concerned about it but it doesn't always translate into action (Lenzen and Cummins, 2011). Studies have found that sustainability conscious behavior is correlated with cost. This issue leads to various factors such as education, wealth inequality, and the link between the two in terms of sustainable behavioral actions within people's lifestyle. This variable effect the correlation between awareness and behavior (Diekmann and Preisendoeffer, 1992). Since proven that sustainability awareness is not enough to promote behavioral change, action based strategies are critical.

There is a new interest in behavior-based strategies through education by raising awareness among faculty, staff and students. A behavior-based program such as the Center for Green Schools at the United States Green Building Council (USGBC) created a toolkit that could reduce from 20-37% electricity use in schools solely on behavior without capital investment or mechanical upgrades as seen on Table 1 (Crosby, 2013).

Table 1 Drop in Electricity use Due to Behavior-Based Energy Consumption Strategies

DROP IN ELECTRICITY USE DUE TO BEHAVIOR-BASED ENERGY CONSERVATION STRATEGIES

SCHOOL	Annual Reduction in Electricity Usage vs. Baseline Year		Annual Cost Savings vs. Baseline Year		Length of Time Covered by Energy Data	Baseline Year
	%	kilowatt-hour (kWh)	%	$		
Holston MS *Knoxville, TN*	-37%	-848,929	-12%	-$19,816	6 years	Fiscal Year 2007
Rosa Parks ES *Lexington, KY*	-36%	-645,900	-20%	-$24,500	4 years	Fiscal Year 2009
Laguna Creek HS *Elk Grove, CA*	-30%	-663,232	-19%	-$47,704	4 years	Fiscal Year 2009
Henderson HS *West Chester, PA*	-30%	-1,359,672	-28%	-$121,821	5 years	Calendar Year 2008
John Jacobs ES *Phoenix, AZ*	-20%	-250,797	-10%	-$12,463	5 years	Mar., 2007 - Feb., 2008

These five different schools from across the United States recorded their annual reduction in electricity usage and annual savings by implementing shared elements and behavior-based strategies. The avenues to achieve the common goal was to raise awareness to faculty, staff and students as well as manage school building operations. These strategies are relatively easy and cost efficient to introduce with the capability of significant results. Educating each school's occupants on energy-saving behavioral strategies such as turning off the lights when classes were unoccupied significantly reduced standby power (Crosby, 2013). The sustainable choices these education institutions' occupants achieved reflected on the recorded annual electricity consumption was significantly lower compared to the baseline year.

There are significant savings involved in the implementation of behavior-based strategies depicted in Table 1. Ranging from $12,000-$122,000 in annual savings, and reducing the electricity consumption by 250,000-1,360,000 kWh, the 5 schools achieved these reductions at minimal costs through behavior-based strategies. The United States Environmental Protection Agency (EPA) estimates that through conservation and efficiency, $2 billion out of $8 billion spent annually on energy in schools will be saved.

The second benefit of implementing behavior-based strategies in educational institutions is the environmental impact. Reducing electricity minimizes greenhouse gas production, air pollution and mercury in the environment. The third benefit is the learning and leadership opportunities involved in the process for the faculty, staff and students. The benefits of behavior-based strategies implemented in these five schools are compelling. These cost savings can be invested into the school to improve or upgrade the mechanical equipment and controls to further improve its efficiency. This behavioral change approach can be implemented in water reduction, waste reduction, and CO_2 Emissions reduction.

A study on reducing carbon emissions through behavioral and lifestyle change measures in residential use was conducted in 2015 at the Copernicus Institute of Sustainable Development, Utrecht University, in the Netherlands. They explored its implications through an Integrated Assessment Model (IAM) to examine the strengths and limitations of the following questions:

- *How can lifestyle and lifestyle change be included in an integrated assessment model?*
- *How much could a set of lifestyle changes contribute to achieving 2 °C climate targets, given the interaction with other measures?*

(van Sluisveld et al., 2015)

To measure changes in lifestyle, this study focused on curtailment measures since people are most prone to act on environmentally friendly behavior changes with low cost and low efforts. The IAM studied framework of lifestyle changes in terms of household domain such as space heating, water heating, appliance use, efficiency of appliances, waste management, and transport domain in terms of energy use, and mobility. Through their research, it was found that 13% of the total 32% of emissions responsible in the residential and commercial sector can be reduced through lifestyle and behavior change (van Sluisveld et al., 2015). Table 2 demonstrates behavioral tendencies influencing the adoption of energy efficient technologies.

Table 2 Behavioral tendencies influencing the adoption of Energy Efficient Technology (adapted from Moglia et al., 2017; Frederiks et al., 2015; Knobloch & Mercure 2016; Sorrell, Mallett, & Nye, 2011).

Behavioral tendency	Description	Implication for policy
Inertia	People have a tendency to want to stick with the status quo rather than having to change, for practical reasons and for convenience; as they like to avoid hidden costs associated with a switch	Until new solutions become the norm, people are likely to resist change and may require considerable convincing
Satisficing	People don't tend to optimize their decision but rather aim to satisfy a small set of criteria, i.e. the minimum requirements	This means that the availability of products is critical because as long as these fulfil the minimum requirements, they will be chosen
Being loss and risk averse	People weight losses more than gains when making decisions and people tend to avoid the prospect of a loss even with the prospect of certain gains, and tend to accept a gamble in order to avoid a loss	It is important to address concerns about losses and any potential risks as these will disproportionately influence the adoption decision
Persisting with sunk costs	Once people have invested in something, in terms of time and/or money, they tend to become fixated on 'recovering losses'	Take care to frame communications around energy efficiency in a way that does not amplify any concerns about sunk costs
Social comparisons	People tend to follow the behaviour of others, i.e. following the norm	This reinforces dominant technologies and creates inertia at the start of an adoption curve, but conversely, amplifies uptake when adoption rates cross certain thresholds
Irrational response to monetary incentives	People's response to incentives are often short-lived and unpredictable and may crowd out intrinsic motivations	Non-monetary incentives often work more effectively than monetary incentives
Free-riding effect	People tend to look for ways that they can gain benefits without paying for them	Build social cohesion and capital as a counterpoint to the free-riding behaviour and appeal to people's desire to benefit the greater good
Trust	People seek information and judgments from those that they trust	Work with trusted sources of information
Availability bias	People primarily draw on knowledge and information that is easily accessible. Lack of information may mean that some opportunities are missed.	Create heuristics (such as efficiency ratings) and make them easily accessible, and create communications that appeal to this sentiment. Make sure information is well-known.
Split incentives	Opportunities may not be taken if it is not possible for individuals to appropriate the benefits of the investment	Target information and incentives at those decision-makers who are likely to benefit from adoption.
Bounded rationality	There is a cognitive effort in analyzing which option is better, and humans often opt for simpler way of making decisions such as through imitation or inquiry.	Don't assume that residents will always make decisions based on rigorous analysis but will sometimes be swayed by friends or other information sources' recommendations.

This table concludes how the urgent need for energy efficiency in the residential sector can be mitigated through the adaptation of energy efficiency technologies influenced by a wide variety of factors.

To conclude, individuals in higher education are observed to be more sustainable. Evidence is lacking in this observation because of the variety of variables that are omitted that result in individuals attaining more education and the cause of individuals to be more sustainability conscious. One of the variable for example, can be that individuals in higher education are more educated in financial savings which is why they partake in more sustainability conscious actions (Meyer, 2015). In this variable, individuals are simply better economizers and manifest more sustainable conscious actions. In order for change to occur, individuals should have a set congruence between information, emotions and behavioral attitudes with what is done to achieve actions (Sammalisto, et al, 2016). Overall, it is observed that individuals in higher education are more sustainability conscious since they are better economizers, practice sustainable actions as opposed to students in secondary education who are aware of sustainability an don't practice sustainable behaviors.

1.2 Sustainability Definition

Sustainability is a common word that's being tossed around today but what really is it? Sustainability has been defined as "[meeting] the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland et al, 1987). There is a worldwide sustainability movement that exists across many disciplines such as Education, Architecture, Engineering, Social and Natural Sciences, and many others. For example, Leadership in Energy and Environmental Design (LEED) in Architecture, American Water Works Association in the Natural Sciences, the United States Department of Energy in Engineering, Sustainability Education & Economic Development (SEED) and The Association of the Advancement of Sustainability in Higher Education (AASHE) in Education. Since the question of sustainability has risen to prominence, the world is moving to a different era where it is tackling the consequences of climate change and resources depletion (Caliyurt, et al, 2017). Today, more people can talk knowledgeably about their carbon footprint and businesses are making statements about their aim for carbon neutrality (Weidema et al. 2008). To progress in the common goal of sustainability worldwide, educational institutions must play a substantial role in the process of creating awareness, knowledge, skills, values and sustainable action.

1.3 Sustainability Education

The Georgia Department of Education defines environmental education as a learning process that increases knowledge and awareness about the environment and develops skills that enable responsible decisions and actions that impact the environment "[promoting] interdisciplinary learning, encourages inquiry and investigation, and develops problem-solving skills" (Georgia Department of Education, 2015). The United Nations Conference on Environmental Development (UNCED) in Rio de Janeiro, Brazil in 1992 linked sustainability to education and learning. They have identified the improvement of school-age to higher education's capacity to promote and address environmental issues (UNCED, 1992). A sustainability education system is to be implemented in the United States to teach our future generations and help them understand the steps they can take towards a sustainable future. A reflective curricular activity is necessary to cultivate sustainability studies in students' education. Our future generations should learn about sustainability, climate change, pollution, environmental issues, and the critical thinking abilities necessary early in their education to address these issues with the appropriate actions. A sustainability toolkit will create a revolution of a new learning environment that will motivate students to engage in sustainability actions and align them towards the right track from school-age to higher education. This educational tool can positively impact the current education system in the United States and future generations.

To celebrate environmental stewardship and sustainability, this sustainability toolkit must be implemented in all levels of education instead of solely in higher educational institutions. Although there is an increase in environmental awareness, environmental education has only existed in the past 60 years. The subject was first discussed in The International Union for the Conservation of Nature and Natural Resources conference in 1948 (Disinger 1983). Instead of students always seeing the positive image of the world, they should acknowledge both reality and possibility to encourage them to think critically and address issues accordingly in their future disciplines. A linear model of environmental education progression is shown in Figure 1.

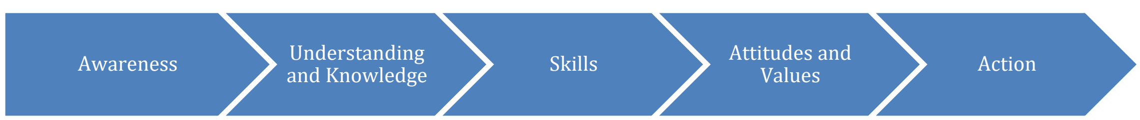


Figure 1 Linear Model of Environmental Education

These stages are fundamental for the sustainability toolkit based on behavioral strategies to be implemented. Education is where behavior can be triggered in order to increase sustainability. Educational institutions must have the moral and ethical responsibility to promote sustainability. A behavioral approach that attains a better understanding of sustainability in educational institutions will gain the understanding of sustainable academic research, ethical and moral responsibility, and an interdisciplinary curriculum to help fix the gap between theory and practice in education. This toolkit will increase environmental stewardship and sustainability actions in educational institutions to shape and mold individuals of society.

Literature Review

1.1 Introduction

Sustainability education exists in all levels of education. Although, sustainability education is much more prominent in higher education institutions as opposed to Elementary, Middle, and High school. Consequently, less students are prepared with the desired sustainability knowledge needed in higher education to instill in their disciplines since behavior and habits are achieved through repetitive actions that were not set as a foundation earlier in their education Sustainability in all levels of education must target its four personnel bodies whom are students, faculty, staff and alumni. The following literature explains existing sustainability education in Secondary Education and Higher Education.

1.2 Sustainability in Secondary Education

Although sustainability in Secondary Education exists, it is difficult to find a set approach that specifically targets sustainability in a hands-on approach as opposed to the broad awareness education on sustainability. Based in Arizona's K-12 Academic standards, students graduating high school must learn nine standards which are:

1. *Arts*
2. *Educational Technology*
3. *English Language Arts/Literacy*
4. *Health Education*
5. *Mathematics*
6. *Physical Education*
7. *Science*
8. *Social Studies*
9. *World and Native Languages*

Based on these academic standards, sustainability in secondary education is mainly taught in Science classes. During science class, broad topics of sustainability are covered and a basic level of awareness is achieved.

High School Science Curriculum

In Arizona's curriculum, sustainability was mainly implemented and learned in science. Based on the current educational topics students in secondary education are required to learn, sustainability education was hardly addressed in The Arizona Department of Education's science concepts. The following topics related to sustainability must be learned in secondary education before graduating based on four strands in the science curriculum which include the following:

1. *Inquiry Process*
2. *History and Nature of Science*
3. *Science in Personal and Social Perspectives*
4. *Life Science*
5. *Physical Science*

Each strand relates to sustainability as their concepts are described in the following tables.

Strand 1: Inquiry Process

Table 3 Inquiry process concept 1. Source: Arizona Department of Education (2016)

Concept 1: Observations, Questions, and Hypotheses Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.
PO 1. Evaluate scientific information for relevance to a given problem. (See R09-S3C1, R10-S3C1, R11-S3C1, and R12-S3C1) PO 2. Develop questions from observations that transition into testable hypotheses. PO 3. Formulate a testable hypothesis. PO 4. Predict the outcome of an investigation based on prior evidence, probability, and/or modeling (not guessing or inferring).

Table 4 Inquiry process concept 2: Source: Arizona Department of Education (2016)

Concept 2: Scientific Testing (Investigating and Modeling) Design and conduct controlled investigations.
PO 1. Demonstrate safe and ethical procedures (e.g., use and care of technology, materials, organisms) and behavior in all science inquiry. PO 2. Identify the resources needed to conduct an investigation. PO 3. Design an appropriate protocol (written plan of action) for testing a hypothesis: • Identify dependent and independent variables in a controlled investigation. • Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes). • Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators). PO 4. Conduct a scientific investigation that is based on a research design. PO 5. Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.

Table 5. Inquiry process concept 3. Source: Arizona Department of Education (2016)

Concept 3: Analysis, Conclusions, and Refinements Evaluate experimental design, analyze data to explain results and propose further investigations. Design models.
PO 1. Interpret data that show a variety of possible relationships between variables, including: • *positive relationship* • *negative relationship* • *no relationship* PO 2. Evaluate whether investigational data support or do not support the proposed hypothesis. PO 3. Critique reports of scientific studies (e.g., published papers, student reports). PO 4. Evaluate the design of an investigation to identify possible sources of procedural error, including: • sample size • trials • controls • analyses PO 5. Design models (conceptual or physical) of the following to represent "real world" scenarios: • carbon cycle • water cycle • phase change • collisions PO 6. Use descriptive statistics to analyze data, including: • mean • frequency • range (See MHS-S2C1-10) PO 7. Propose further investigations based on the findings of a conducted investigation.

Table 6 Inquiry process concept 4. Source: Arizona Department of Education (2016)

Concept 4: Communication Communicate results of investigations.
PO 1. For a specific investigation, choose an appropriate method for communicating the results. (See W09-S3C2-01 and W10-S3C3-01) PO 2. Produce graphs that communicate data. (See MHS-S2C1-02) PO 3. Communicate results clearly and logically. PO 4. Support conclusions with logical scientific arguments.

Strand 2: History and Nature of Science

Table 7 History and Nature of Science concept 1. Source: Arizona Department of Education (2016)

Concept 1: History of Science as a Human Endeavor Identify individual, cultural, and technological contributions to scientific knowledge.
PO 1. Describe how human curiosity and needs have influenced science, impacting the quality of life worldwide. *PO 2. Describe how diverse people and/or cultures, past and present, have made important contributions to scientific innovations.* PO 3. Analyze how specific changes in science have affected society. PO 4. Analyze how specific cultural and/or societal issues promote or hinder scientific advancements.

Table 8 History and Nature of Science concept 2. Source: Arizona Department of Education (2016)

Concept 2: Nature of Scientific Knowledge Understand how science is a process for generating knowledge.
PO 1. Specify the requirements of a valid, scientific explanation (theory), including that it be: • logical • subject to peer review • public • respectful of rules of evidence PO 2. Explain the process by which accepted ideas are challenged or extended by scientific innovation. PO 3. Distinguish between pure and applied science. PO 4. Describe how scientists continue to investigate and critically analyze aspects of theories.

Strand 3: Science in Personal and Social Perspectives

Table 9 Science in Personal and Social Perspectives. Source: Arizona Department of Education (2016)

Concept 1: Changes in Environments Describe the interactions between human populations, natural hazards, and the environment.
PO 1. Evaluate how the processes of natural ecosystems affect, and are affected by, humans. PO 2. Describe the environmental effects of the following natural and/or human-caused hazards: • flooding • drought • earthquakes • fires • pollution • extreme weather PO 3. Assess how human activities (e.g., clear cutting, water management, tree thinning) can affect the potential for hazards. PO 4. Evaluate the following factors that affect the quality of the environment: • urban development • smoke • volcanic dust PO 5. Evaluate the effectiveness of conservation practices and preservation techniques on environmental quality and biodiversity.

Table 10 Science in Personal and Social Perspectives Concept 2. Source: Arizona Department of Education (2016)

Concept 2: Science and Technology in Society Develop viable solutions to a need or problem.
PO 1. Analyze the costs, benefits, and risks of various ways of dealing with the following needs or problems: • various forms of alternative energy • storage of nuclear waste • abandoned mines • greenhouse gases • hazardous wastes PO 2. Recognize the importance of basing arguments on a thorough understanding of the core concepts and principles of science and technology. PO 3. Support a position on a science or technology issue. PO 4. Analyze the use of renewable and nonrenewable resources in Arizona: • water • land • soil • minerals • air PO 5. Evaluate methods used to manage natural resources (e.g., reintroduction of wildlife, fire ecology).

Table 11 Science in Personal and Social Perspectives Concept 3. Source: Arizona Department of Education (2016)

Concept 3: Human Population Characteristics Analyze factors that affect human populations.
PO 1. Analyze social factors that limit the growth of a human population, including: • affluence • education • access to health care • cultural influences PO 2. Describe biotic (living) and abiotic (nonliving) factors that affect human populations. PO 3. Predict the effect of a change in a specific factor on a human population.

Strand 4: Life Science

Table 12 Life Science Concept 1. Source: Arizona Department of Education (2016).

Concept 1: The Cell Understand the role of the cell and cellular processes.
PO 1. Describe the role of energy in cellular growth, development, and repair. PO 2. Compare the form and function of prokaryotic and eukaryotic cells and their cellular components. PO 3. Explain the importance of water to cells. PO 4. Analyze mechanisms of transport of materials (e.g., water, ions, macromolecules) into and out of cells: • passive transport • active transport PO 5. Describe the purposes and processes of cellular reproduction.

Table 13 Life Science Concept 2. Source: Arizona Department of Education (2016).

Concept 3: Interdependence of Organisms Analyze the relationships among various organisms and their environment.
PO 1. Identify the relationships among organisms within populations, communities, ecosystems, and biomes. PO 2. Describe how organisms are influenced by a particular combination of biotic (living) and abiotic (nonliving) factors in an environment. PO 3. Assess how the size and the rate of growth of a population are determined by birth rate, death rate, immigration, emigration, and carrying capacity of the environment.

Table 14 Life Science Concept 4. Source: Arizona Department of Education (2016).

Concept 4: Biological Evolution Understand the scientific principles and processes involved in biological evolution.
PO 1. Identify the following components of natural selection, which can lead to speciation: • potential for a species to increase its numbers • genetic variability and inheritance of offspring due to mutation and recombination of genes • finite supply of resources required for life • selection by the environment of those offspring better able to survive and produce offspring PO 2. Explain how genotypic and phenotypic variation can result in adaptations that influence an organism's success in an environment. PO 3. Describe how the continuing operation of natural selection underlies a population's ability to adapt to changes in the environment and leads to biodiversity and the origin of new species. PO 4. Predict how a change in an environmental factor (e.g., rainfall, habitat loss, non-native species) can affect the number and diversity of species in an ecosystem. PO 5. Analyze how patterns in the fossil record, nuclear chemistry, geology, molecular biology, and geographical distribution give support to the theory of organic evolution through natural selection over billions of years and the resulting present day biodiversity. PO 6. Analyze, using a biological classification system (i.e., cladistics, phylogeny, morphology, DNA analysis), the degree of relatedness among various species.

Table 15 Life Science Concept 5. Source: Arizona Department of Education (2016).

Concept 5: Matter, Energy, and Organization in Living Systems (Including Human Systems) Understand the organization of living systems, and the role of energy within those systems.
PO 1. Compare the processes of photosynthesis and cellular respiration in terms of energy flow, reactants, and products. PO 2. Describe the role of organic and inorganic chemicals (e.g., carbohydrates, proteins, lipids, nucleic acids, water, ATP) important to living things. PO 3. Diagram the following biogeochemical cycles in an ecosystem: • water • carbon • nitrogen PO 4. Diagram the energy flow in an ecosystem through a food chain. PO 5. Describe the levels of organization of living things from cells, through tissues, organs, organ systems, organisms, populations, and communities to ecosystems.

Strand 5: Physical Science

Table 16 Physical Science concept 1. Source: Arizona Department of Education (2016).

Concept 1: Structure and Properties of Matter Understand physical, chemical, and atomic properties of matter.
PO 1. Describe substances based on their physical properties. PO 2. Describe substances based on their chemical properties. PO 3. Predict properties of elements and compounds using trends of the periodic table (e.g., metals, non-metals, bonding – ionic/covalent). PO 4. Separate mixtures of substances based on their physical properties. PO 5. Describe the properties of electric charge and the conservation of electric charge. PO 6. Describe the following features and components of the atom: • protons • neutrons • electrons • mass • number and type of particles • structure • organization PO 7. Describe the historical development of models of the atom. PO 8. Explain the details of atomic structure (e.g., electron configuration, energy levels, isotopes).

Table 17 Physical Science concept 3. Source: Arizona Department of Education (2016).

Concept 3: Conservation of Energy and Increase in Disorder Understand ways that energy is conserved, stored, and transferred.
PO 1. Describe the following ways in which energy is stored in a system: • mechanical • electrical • chemical • nuclear PO 2. Describe various ways in which energy is transferred from one system to another (e.g., mechanical contact, thermal conduction, electromagnetic radiation.) PO 3. Recognize that energy is conserved in a closed system. PO 4. Calculate quantitative relationships associated with the conservation of energy. PO 5. Analyze the relationship between energy transfer and disorder in the universe (2nd Law of Thermodynamics). PO 6. Distinguish between heat and temperature. PO 7. Explain how molecular motion is related to temperature and phase changes.

Table 18 Physical Science concept 5. Source: Arizona Department of Education (2016).

Concept 5: Interactions of Energy and Matter Understand the interactions of energy and matter.
PO 1. Describe various ways in which matter and energy interact (e.g., photosynthesis, phase change). PO 2. Describe the following characteristics of waves: • wavelength • frequency • period • amplitude PO 3. Quantify the relationships among the frequency, wavelength, and the speed of light. PO 4. Describe the basic assumptions of kinetic molecular theory. PO 5. Apply kinetic molecular theory to the behavior of matter (e.g., gas laws). PO 6. Analyze calorimetric measurements in simple systems and the energy involved in changes of state. PO 7. Explain the relationship between the wavelength of light absorbed or released by an atom or molecule and the transfer of a discrete amount of energy. PO 8. Describe the relationship among electric potential, current, and resistance in an ohmic system. PO 9. Quantify the relationships among electric potential, current, and resistance in an ohmic system.

Strand 6: Earth and Space Science

Table 19 Earth and Space Science concept 1. Source: Arizona Department of Education (2016).

Concept 1: Geochemical Cycles Analyze the interactions between the Earth's structures, atmosphere, and geochemical cycles.
PO 1. Identify ways materials are cycled within the Earth system (i.e., carbon cycle, water cycle, rock cycle). PO 2. Demonstrate how dynamic processes such as weathering, erosion, sedimentation, metamorphism, and orogenesis relate to redistribution of materials within the Earth system. PO 3. Explain how the rock cycle is related to plate tectonics. PO 4. Demonstrate how the hydrosphere links the biosphere, lithosphere, cryosphere, and atmosphere. PO 5. Describe factors that impact current and future water quantity and quality including surface, ground, and local water issues. PO 6. Analyze methods of reclamation and conservation of water. PO 7. Explain how the geochemical processes are responsible for the concentration of economically valuable minerals and ores in Arizona and worldwide.

Table 20 Earth and Space Science concept 2. Source: Arizona Department of Education (2016).

Concept 2: Energy in the Earth System (Both Internal and External) Understand the relationships between the Earth's land masses, oceans, and atmosphere.
PO 1. Describe the flow of energy to and from the Earth. PO 2. Explain the mechanisms of heat transfer (convection, conduction, radiation) among the atmosphere, land masses, and oceans. PO 3. Distinguish between weather and climate. **Internal Energy:** PO 4. Demonstrate the relationship between the Earth's internal convective heat flow and plate tectonics. PO 5. Demonstrate the relationships among earthquakes, volcanoes, mountain ranges, mid-oceanic ridges, deep sea trenches, and tectonic plates. PO 6. Distinguish among seismic S, P, and surface waves. PO 7. Analyze the seismic evidence (S and P waves) used to determine the structure of the Earth. PO 8. Describe how radioactive decay maintains the Earth's internal temperature. **External Energy:** PO 9. Explain the effect of heat transfer on climate and weather. PO 10. Demonstrate the effect of the Earth's rotation (i.e., Coriolis effect) on the movement of water and air. PO 11. Describe the origin, life cycle, and behavior of weather systems (i.e., air mass, front, high and low systems, pressure gradients). PO 12. Describe the conditions that cause severe weather (e.g., hurricanes, tornadoes, thunderstorms). PO 13. Propose appropriate safety measures that can be taken in preparation for severe weather. PO 14. Analyze how weather is influenced by both natural and artificial Earth features (e.g., mountain ranges, bodies of water, cities, air pollution). PO 15. List the factors that determine climate (e.g., altitude, latitude, water bodies, precipitation, prevailing winds, topography). PO 16. Explain the causes and/or effects of climate changes over long periods of time (e.g., glaciation, desertification, solar activity, greenhouse effect). PO 17. Investigate the effects of acid rain, smoke, volcanic dust, urban development, and greenhouse gases, on climate change over various periods of time.

Table 21 Earth and Space Science concept 1. Source: Arizona Department of Education (2016).

Concept 3: Origin and Evolution of the Earth System Analyze the factors used to explain the history and evolution of the Earth.
Earth Origin/System: PO 1. Describe the scientific theory of the origin of the solar system (solar nebular hypothesis). PO 2. Describe the characteristics, location, and motions of the various kinds of objects in our solar system, including the Sun, planets, satellites, comets, meteors, and asteroids. PO 3. Explain the phases of the Moon, eclipses (lunar and solar), and the interaction of the Sun, Moon, and Earth (tidal effect). **Earth History/Evolution:** PO 4. Interpret a geologic time scale. PO 5. Distinguish between relative and absolute geologic dating techniques. PO 6. Investigate scientific theories of how life originated on Earth (high temperature, low oxygen, clay catalyst model). PO 7. Describe how life on Earth has influenced the evolution of the Earth's systems. PO 8. Sequence major events in the Earth's evolution (e.g., mass extinctions, glacial episodes) using relative and absolute dating data. PO 9. Analyze patterns in the fossil record related to the theory of organic evolution.

These concepts introduced in secondary education science cover broad topics of sustainability. These topics aware students about sustainability but since awareness does not correlate to sustainability action, this system is not molding students into sustainable conscious young adults.

Case Studies

There is a worldwide sustainability initiative occurring today. The Vermont Energy Education program (VEEP), for example, is a program whose mission is to "Promote Energy Literacy: A deep understanding of what energy is and how to use it efficiently to enable energy usage choices that will result in a sustainable and vital economy and a healthy environment" (Vermont, 2016). The program hosts regular workshops on energy efficiency, renewable energy, and climate change. This program also initiates team-based projects to reduce carbon emissions, carbon footprint and fossil fuels by increasing efficiency, conservation and renewable energy generation. The VEEP Educational program is an exemplary educational tool that can be used as model for educational institutions.

Another example of an ideal sustainability education system is Changemaker High School (CMHS), a public charter school in Tucson, Arizona. As in VEEP, CMHS focuses on engaging activities that accommodate to arid regions. For example, their Urban Agriculture Lab works with greenhouses propagating plants, composing and planting. Through participatory research, teachers and students also gather data on community safety and health to propose solutions through projects to fulfill the community's need. Their art room consists of students creating paintings that speak to civic engagement as well as global transformation. The Changemaker Lab is designed as a space to create projects through small group meetings and put them into action such as recruiting potential community partners to broaden their learning spectrum. At Changemaker, students are trained to be leaders in their community from their constant ideas put into action, problem solving, and team working skills combined towards a positive change. The school's mission is to prepare their students not only with the core curriculum, but to go above and beyond to engage students in real-world issues. Some of the student-created posters on the wall of the high school reads, "Don't Make Excuses: Make Change," "Be the Change you Want to See in the World," and "Once a Changemaker, Always a Changemaker," to continually motivate their students to do their best (Cato, 2016). CMHS is an inspiring example of an educational system that sets sustainability as a priority preparing students to initiate positive change for the greater good by incorporating problem solving, teamwork, and leadership in their core curriculum.

At CMHS, students are not only encouraged to become active members of the community but are required to identify challenges and propose solutions for these challenges. These ideas are presented twice a year where they are judged by local representatives. This project is called Pitch-a-thon where students at CMHS propose a pitch by presenting foundational research, business strategies and accountability plans. CMHS describes the students' ideas as, "creative and diverse, and are grounded in the personal experiences of the students" (Cato, 2016). The following statement describes what some of the launched student-based projects have completed:

> *"One student, who came to this country as a refugee, is organizing a 5K run in support of local refugee relocation initiatives. Another student has successfully launched a project to support teens struggling with body image issues, which she herself battled with as a young teen. Homelessness, food insecurity, sustainability and community health and wellness are other examples of issues being tackled by*

the students" (Cato, 2016).

At CMHS, the education system is focused on action-based projects where proposed solutions are launched and processed into a plan. They are engaged in real world issues and are focused on creativity, problem solving, teamwork, and leadership. CMHS is a model to learn from since these students are educated on the same level as higher education students would be at an earlier age in terms of sustainability education.

1.3 Sustainability in Higher Education

The efforts of sustainability in Higher Education have been a marching banner in most recent years, although, there is still much resistance to change, transform and reimagine society and higher education for sustainability. Most of the 100 leaders attending the World Summit for Sustainable Development in Johannesburg in 2002 who failed to rise to the challenge of sustainability had higher degrees from the world's best universities (Jones, Selby, Sterling, 2010). Graduating from the world's best universities won't create leaders who are sustainability conscious unless sustainability education is engraved earlier on. Today, two-thirds of incoming college freshman look at campus green rankings as a factor in college choice (Pryor et al., 2008; Princeton Review, 2016). The gap between theory and practice is a challenge that can benefits the entire world if educational measures are developed to improve sustainability education. Even though higher education institutions and organizations are advocating for sustainability, to create significant change, the topic must be introduced early on.

Sustainability Declarations

The United Nations Educational, Scientific, Cultural Organization (UNESCO) is focused on teaching and learning for a sustainable future. It has areas of emphasis on biodiversity, climate change and education, disaster risk reduction, cultural diversity, water conservation, sustainable urbanism, health promotion and poverty reduction. Ever since *The Stockholm Declaration* (UNESCO, 1971), international sustainability in higher education has been steadily developed through declarations as seen in the timeline on Figure 2.

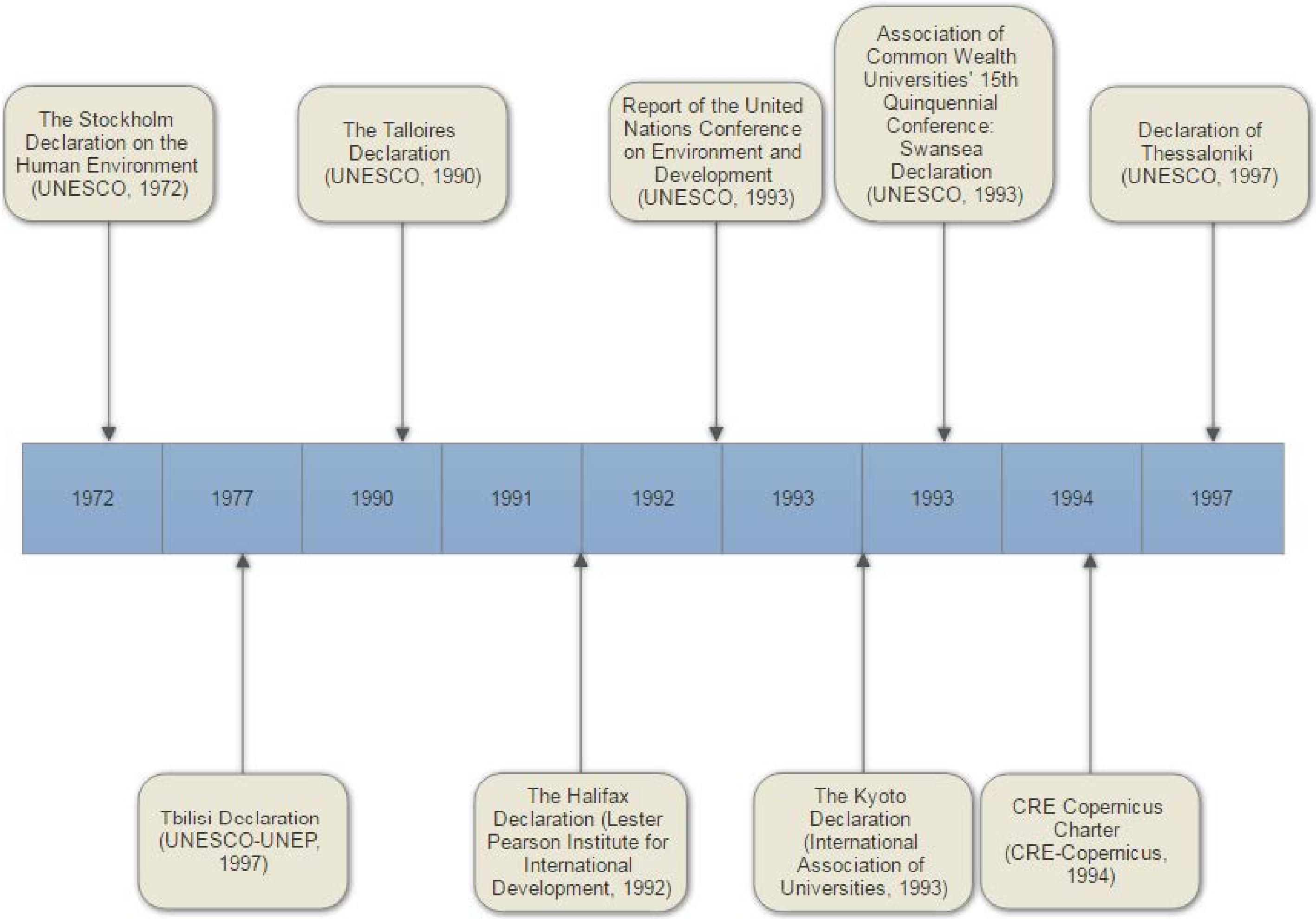


Figure 2 Sustainability Declarations in Higher Education

The declarations outlined above have been a setting stone for sustainability education movements across the nation. Some of the most influential declarations are defined as follows.

The Stockholm Declaration

The first declaration to make reference to sustainability in higher education was The Stockholm Declaration of 1972 and recognized the interdependency between the environment and humanity. It focused on the improvement of the human environment of and goals of peace, social and development for present and future generations. (Wright, 2002). Out of the 24 principles, Principle 19 offered to achieve environmental sustainability, one of the principles pointed out the need for environmental education in hopes of enlightening individuals' sustainability actions and protect and improve the environment (UNESCO, 1972). The relevance of the Stockholm Declaration to higher education alarmed the public of the education issues occurring at the time and has been a basis for an initiative towards environmental education.

The Tblisi Declaration

The Intergovernmental Conference on Environmental Education in Tblisi sponsored by UNESCO and the United Nations Environmental Program (UNEP) elaborated on the Tblisi Declaration's principal characteristics. The conference stated that "Environmental education should be provided to people of all ages, all levels of academic aptitude and must be delivered in both formal and non-formal environments" (Wright, 2002). The declaration highlighted characteristics on higher education and guidelines for institutions to consider environmental and sustainability issues within the general university framework. The Tblisi Declaration was the first to develop sustainability initiatives within higher education.

The Talloires Declaration

In response to the urgent challenge of sustainability education, The Talloires Declaration in 1990 was the first to commit university administrators to provide leadership and support to their institutions. Universities who signed the declaration were expected to collaborate towards environmental sustainability (Wright, 2002). The Taillores Declaration has been signed by over 270 universities (The Association of University Leaders for a Sustainable Future, 2001). This declaration set a benchmark for institutions in higher education worldwide.

The Halifax Declaration

The Halifax Declaration of 1991 was declared at the Conference on University Action for Sustainability Development in Halifax, Canada. Its purpose was to consider how universities can play a role in addressing environment and development issues of countries worldwide. The declaration was set on the re-thinking and re-construction of environmental policies to contribute to sustainable development practices. The Halifax Declaration was new in the sense that it created an Action Plan that had short and long-term goals for Canadian universities to continue sustainability actions (Wright, 2002). The Halifax Declaration was a continuum of The Talloires Declaration's goals towards sustainability education.

The Kyoto Declaration

The Kyoto Declaration of 1993 was founded after the Ninth International Association of Universities Round Table in 1990 due to a need for vision towards attaining sustainability at higher education institutions (Wright, 2002). It brought up the need for institutional actions and ethical obligations to care for the environment as well as the need to not only teach sustainability but be sustainable through the university's operations. This declaration not only promoted sustainability education but also expected institutions to become sustainable models among other universities.

The Swansea Declaration

The Swansea Declaration of 1993 was founded to make institutions responsible for the environment and society's civilized well-being. It included all of the past declaration's expectations as well as adding the need for richer institutions to help the institutions with more immediate priorities to equalize the level of understanding in environmental sustainability programs (Wright, 2002). Equality of sustainability education among institutions worldwide was the major improvement to prior declarations that The Swansea Declaration acquired.

The CRE-Copernicus Charter

The CRE-Copernicus Charter of 1993 started in the Conference of European Rectors (CRE) to create a new framework for environmental values and sustainable societies within the higher education community such as public outreach, environmental literacy and the encouragement of partnerships (Wright, 2002). It also called upon the need for networking within universities to grow the environmental understanding and capture a greater audience.

The Thessaloniki Declaration

The Thessaloniki Declaration of 1997 was developed by the UNESCO Conference on Environment and Society: Education and Public Awareness for Sustainability. It increased awareness on the importance of radical change to occur for positive environmental actions to transpire. The declaration argued that change must occur in all levels of society and linked to worldwide issues such as poverty, food security, democracy, human rights, peace and health with knowledge White, 2002). This declaration stated the first holistic approach in the higher education curriculum that was interdisciplinary in nature.

These declarations were created for higher educational institutions to sign and abide by them to introduce sustainability. Many institutions have signed these declarations although there are some institutions that opt out of signing but are strong advocators and leaders in sustainability initiatives. For example, The University of Waterloo in Ontario has not signed any international sustainability declarations yet has strong environmental policy (Dearden and Mitchell, 1998). The University of Buffalo in New York has signed declarations such as the *Talloires Declaration* and has multiple policies in environmental sustainability (Beveridge, et al, 2015). This proves that an institution does not have to sign a declaration to create sustainability policies, although declarations do aid in the advancement of sustainability in higher education.

Sustainability Organizations

The United Nations Decade of Education for Sustainable Development (UNESCO)

UNESCO for 2005-2014 stated that higher education would play a critical role during the decade:

> *"Universities must function as places and learning for sustainability development...Higher education should also provide leadership by practicing what they teach through sustainable purchasing, investments and facilities that are integrated with teaching and learning…Higher education should emphasize experiential, inquiry-based problem solving, interdisciplinary systems approaches and critical thinking. Curricula need to be developed, including content, material and tools such as case studies and identification of best practices."* (UNESCO, 2004)

Given the significant commitment towards sustainability related policy and practice, universities should incorporate sustainable perspectives in all disciplines. In 2004, the University of Plymouth adopted a systematic approach to sustainability curriculum development at a university level. The University of Plymouth developed a University Sustainability Policy and Action based on a holistic approach model where Curriculum, Campus, Community and Culture are focused on a sustainable university that is illustrated in Figure 3 (Dyer et al, 2006).

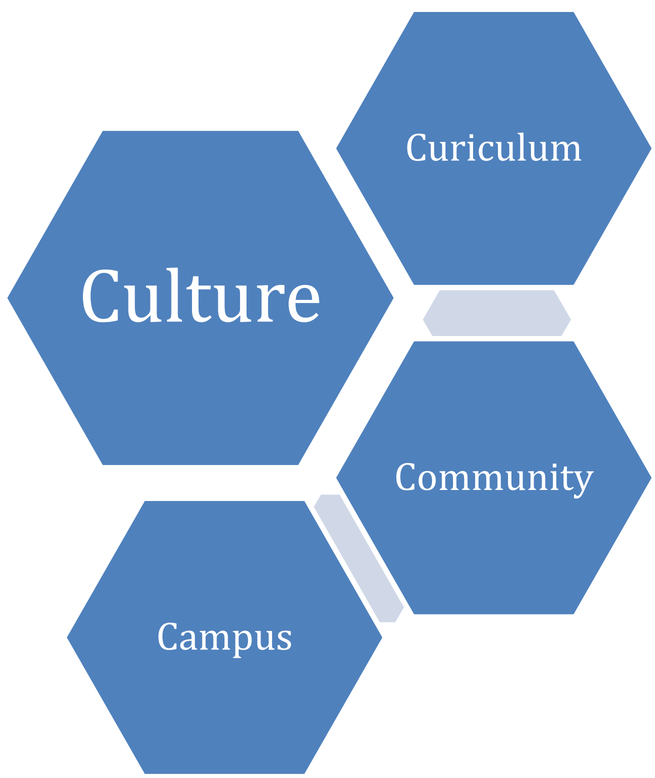


Figure 3 Holistic Approach at the University of Plymouth

The University’s four C’s approach engages students in real-world issues where action is based on values and theory learned throughout.

Environmental Protection Agency (EPA)

EPA is an agency of the federal government of the U.S. that works towards writing and enforcing regulations to protect human health and the environment based on laws passed by Congress (EPA, 2014). The EPA’s sustainability plan for higher education is an example of sustainability efforts in higher education. The U.S. Environmental Protection Agency (EPA) estimates that 25% of energy use in schools is wasted and ways to reduce energy use is critical (Energy Efficiency Programs in K-12 Schools, 2016). The EPA promotes education on emission reductions, energy efficiency, sustainable buildings, renewable energy, fleet management, water conservation, pollution prevention waste reduction, and climate change resilience.

The Association of the Advancement of Sustainability in Higher Education (AASHE)

The Association of the Advancement of Sustainability in Higher Education (AASHE) is another program that is pushing towards sustainability. AASHE has held multiple conferences for leaders to gather and create goals towards a sustainable future. The goals for AASHE’s 2008 conference were the following:

1. *Advance sustainability practices on campus and beyond through partnerships and collaborations.*
2. *Increase the integration of social responsibility and social justice into mainstream campus sustainability.*
3. *Promote new pathways for elevating sustainability education and student leadership development.*
4. *Magnify the role of campuses as responsible members of communities, both local and global.*
5. *Involve a wider range of participants in advancing sustainability in higher education.* (Raleigh, 2008)

AASHE conference is the largest gathering in the nation that brings together multiple sectors of the higher education community. AASHE created the Sustainability Tracking, Assessment & Rating System (STARS) which measures sustainability at universities through sustainability tracking, assessment and rating system. AASHE has become a model of sustainability education that universities abide by.

USGBC for Green Schools

USGBC for Green Schools work with school decision makers, community volunteer and public and private sectors to progress in sustainability education in congruence with the built environment. They are involved in working with campuses as living labs. They work towards energy savings, water efficiency, emission reduction, improved air quality and stewardship of resources. This campaign focuses on extracurricular activities, maintenance and operations in their campus.

COPERNICUS Alliance

COPERNICUS Alliance (European Network on Higher Education for Sustainable Development) provides resources in higher education institutions, society and public policy. This alliance is based on the COPERNICUS Charta in 1993 that has been signed by 326 universities (Mader, 2011). The goals in this alliance include the following:

1. *Policy: to cooperate with European policy to strengthen the role of sustainability in the future development of European research programs and higher education policies;*
2. *Service: to disseminate tools for the integration of sustainability in higher education;*
3. *Outreach: to promote higher education for sustainable development in Europe;*
4. *Representation: to represent European higher education in international committees on education for sustainable development;*
5. *Network: to exchange and enhance knowledge on education for sustainable development between European higher education and student organizations that work for sustainable development (Mader, 2011).*

The integration of sustainability development in higher education institutions is critical to the COPERNICUS Alliance.

Architecture 2030

Architecture 2030 is an organization focused on the reduction of fossil fuel consumption, greenhouse gas emissions, and the development of resilient built environments. Building operations and construction make up roughly 45% of the United States CO_2 emissions, 75% of US electricity consumption, and 48% of US energy consumption (Barnes, Parrish, 2016). Architecture 2030 aims to have a minimum reduction of 20% below national average by 2020 in energy use, water use, and CO_2 emissions reaching 50% by 2030. The building sector can reduce its greenhouse gas emissions by 90% in 2050 compared to 1990 (Becchio, et al, 2016). Architecture 2030 sets goals for existing and future developments to improve the building sector and reduce energy use, water use, and CO_2 emissions.

Conclusion

Educational sustainable methods exist across multiple levels of education such as in high school and higher education. Although most sustainable education methods exist in higher education. National campaigns related to green buildings, carbon neutrality, renewable energy, sustainability education have increased sustainability at institutions worldwide. These methods should be administered earlier on in high school with the recent understanding of sustainability and the current environmental degradations being faced today. The creation of environmental sustainability declarations and individual institutional policies has set a fundamental macro and micro approach towards sustainability. Educational institutions must feed off of professional memberships and organizations to establish a network of invaluable resources. All students should attend schools that sustain their environment and prepares them for 21st century careers.

Problem Statement

The gap between theory and practice of sustainability is substantial. Educational institutions must be the leaders in this subject to mold the future generation's incoming leaders into sustainability conscious critical thinkers. Current environmental issues such as climate change, CO_2 Emissions, poverty and so on must impact these educational institutions to make sustainability education a priority in its curriculum. Addressing this problem requires a holistic approach which integrates sustainability education earlier on to grasp further understanding of sustainability actions in higher education and in society.

To identify the gap between theory and practice, a pilot comparative analysis was conducted. This survey targeted 120 students, distributing half of the surveys to a high school and the other half surveyed at the University of Arizona at random from students.

This study uses a survey formatted through a series of 12 questions to analyze three different study variables: 1) whether students in high school and higher education knew about sustainability 2) whether students' lifestyle consisted of pro-environmental actions, 3) and whether they learned to perform these actions in high school or higher education. This survey resulted in 72 possible outcomes per survey. The survey distributed is demonstrated as follows.

Name:
School/College/University:

Survey is a Graduate research to understand ***sustainability*** *behaviors and their link to* ***Education****. Please answer as accurate as possible in order to attain valid results.*

1. I turn off the lights when not in use.
    a. Yes
    b. No

Where did you learn about it?
    c. High School
    d. Higher Education
    e. None of the above

2. I lower my Air Condition and/or Heater Temperature when I leave the building.
    a. Yes
    b. No

Where did you learn about it?
    c. High School
    d. Higher Education
    e. None of the above

3. I utilize passive methods to cool or heat my environment (Opening/closing window, sit in the sun, choice of clothing)
    a. Yes
    b. No

Where did you learn about it?
    c. High School
    d. Higher Education
    e. None of the above

4. I turn off the water when not in use while conducting activities such as (Brushing Teeth, Shaving, Washing Dishes, etc.)
    a. Yes
    b. No

Where did you learn about it?
    c. High School
    d. Higher Education
    e. None of the above

5. I reduce my shower and bathing times.
    a. Yes
    b. No

Where did you learn about it?
    c. High School
    d. Higher Education

e. None of the above

6. I irrigate plants in an efficient manner through incorporating (Timers, Native Plants, Etc.)
    a. Yes
    b. No

Where did you learn about it?
    c. High School
    d. Higher Education
    e. None of the Above

7. I recycle on a consistent basis.
    a. Yes
    b. No

Where did you learn about it?
    c. High School
    d. Higher Education
    e. None of the above

8. I utilize Biodegradable items frequently while purchasing.
    a. Yes
    b. No

Where did you learn about it?
    c. High School
    d. Higher Education
    e. None of the above

9. I compost my food waste.
    a. Yes
    b. No

Where did you learn about it?
    c. High School
    d. Higher Education
    e. None of the above

10. I often use shared based transportation (Bus, Carpooling, Subway, Etc.)
    a. Yes
    b. No

Where did you learn about it?
    c. High School
    d. Higher Education
    e. None of the above

11. I often Walk or Bike as means of transportation.
    a. Yes

b. No

Where did you learn about it?

c. High School
d. Higher Education
e. None of the above

12. I buy local products as opposed to large incorporations products.

a. Yes
b. No

Where did you learn about it?

c. High School
d. Higher Education
e. None of the above

This survey focused specifically on four factors of sustainability which are Water Use, CO_2 Emissions, Waste Output and Energy Consumption. These questions were molded for students to answer if they are currently reducing water usage, CO_2 emissions, and energy consumption in their regular routines. Each sustainability factor had three specific questions related to their sustainability actions. It also answered where they learned to behave that way either in High School, Higher Education or Other. The students who answered other were automatically ignored since this survey wanted to specifically target those students whom learned about their sustainability action either in Higher Education or High School.

The following tables depict the total sustainability knowledge practiced based on the four factors of sustainability explained. Results illustrate a higher number of students in secondary education not practicing pro-sustainability behavioral actions as opposed to higher education students whom are most prone to practicing sustainability behavioral actions. This represents a disconnection between education and practice. It can be concluded from these results that higher education leads to greater sustainability behavioral actions as illustrated in Tables 22 and 23.

Table 22 Students Practicing Efficient Strategies in Secondary Education

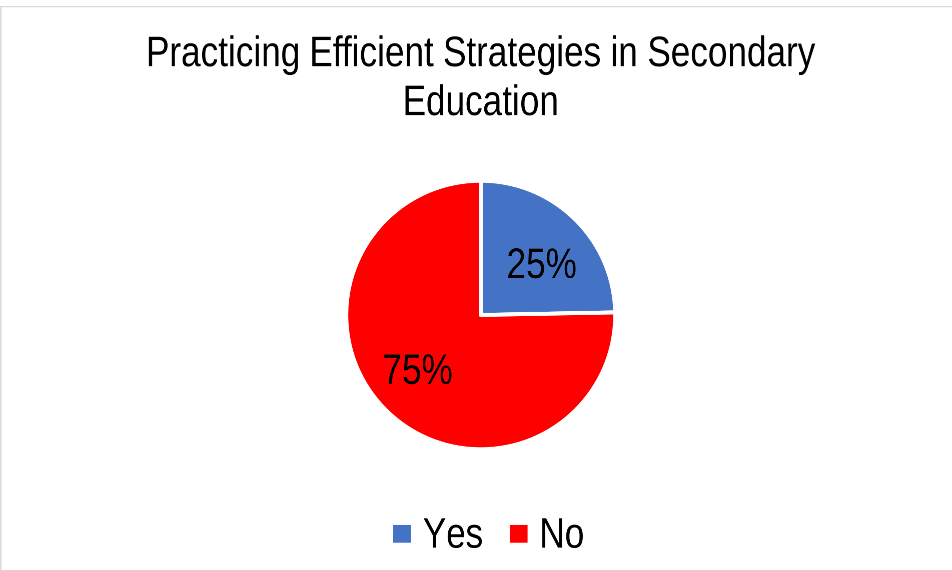


Table 22 explains how 75% of students who learned about sustainable efficient strategies in secondary education are not practicing pro-sustainable actions.

Table 23 Students Practicing Efficient Strategies in Higher Education

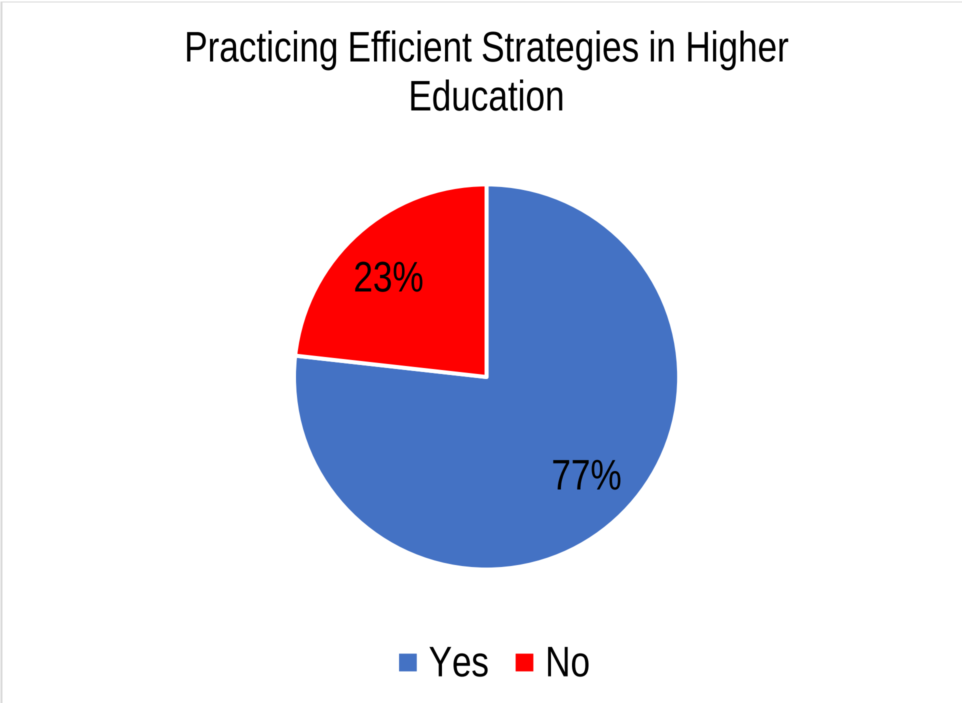
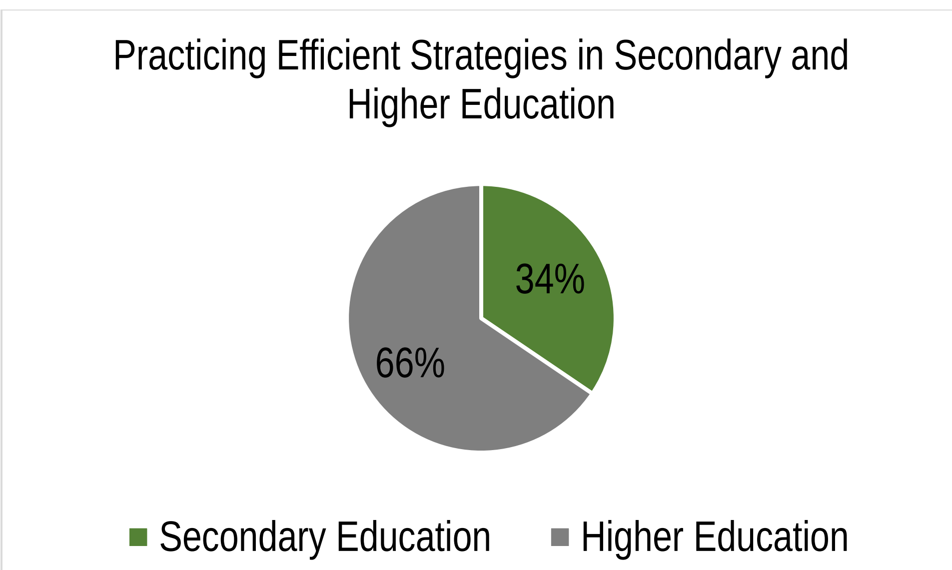


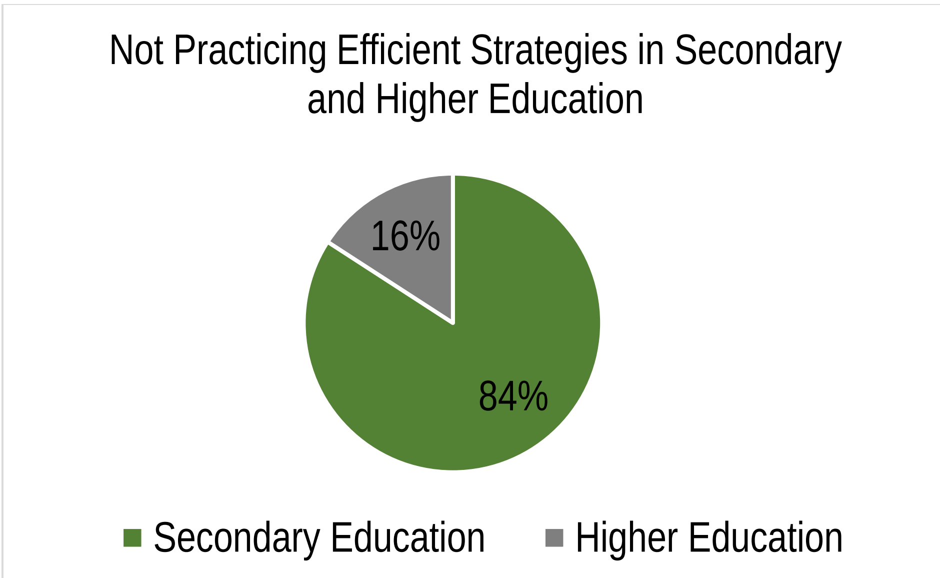
Table 23 explains how only 23% of students who learned about sustainable efficient strategies in higher education are not practicing pro-sustainable actions while 77% of students are practicing pro-sustainable actions. Table 24 show students practicing sustainability actions who learned them in Higher Education compared to those who are practicing and learned them in Secondary Education.

Table 24 Practicing Sustainability Actions in Secondary Education Vs. Higher Education



Results show that 66% of students who learn about sustainability strategies in higher education are actually practicing them as opposed to 34% of secondary education students who are practicing sustainability actions. Table 25 show students not practicing sustainability actions who learned them in Higher Education compared to those who are not practicing and learned them in Secondary Education.

Table 25 Not Practicing Sustainability Actions in Secondary Education Vs. Higher Education



Results show that 84% of students who learned about sustainability action in Secondary Education are not practicing these actions. These results are critical because it is showing that most students in secondary education are not practicing sustainability actions when compared to students in higher education.

Since the questions are specific to four factors of sustainability actions which are water usage, CO2 emissions, waste output and energy consumption, the following charts show the results in each category in terms of sustainability actions in Higher Education and Secondary Education and whether they were practicing them. In terms of energy usage, 23% answered that they tend to practice energy efficient strategies. These strategies were learned in Secondary Education and 77% don't practice them as illustrated in Table 26.

Table 26 Students Practicing Energy Efficient Strategies in Secondary Education

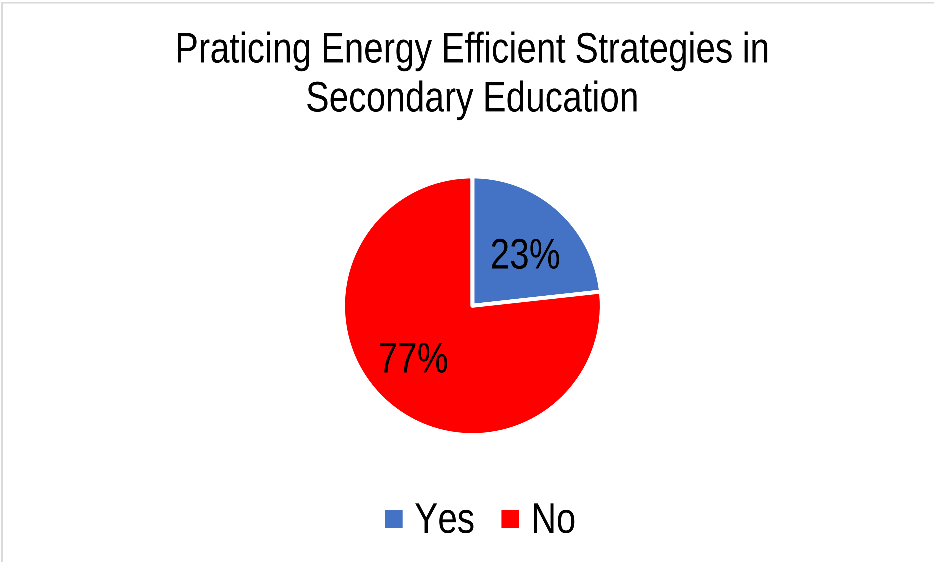


Table 27 explains how 80% of students who learned about energy efficient strategies in higher education are practicing pro-sustainable actions.

Table 27 Students Practicing Energy Efficient Strategies in Higher Education

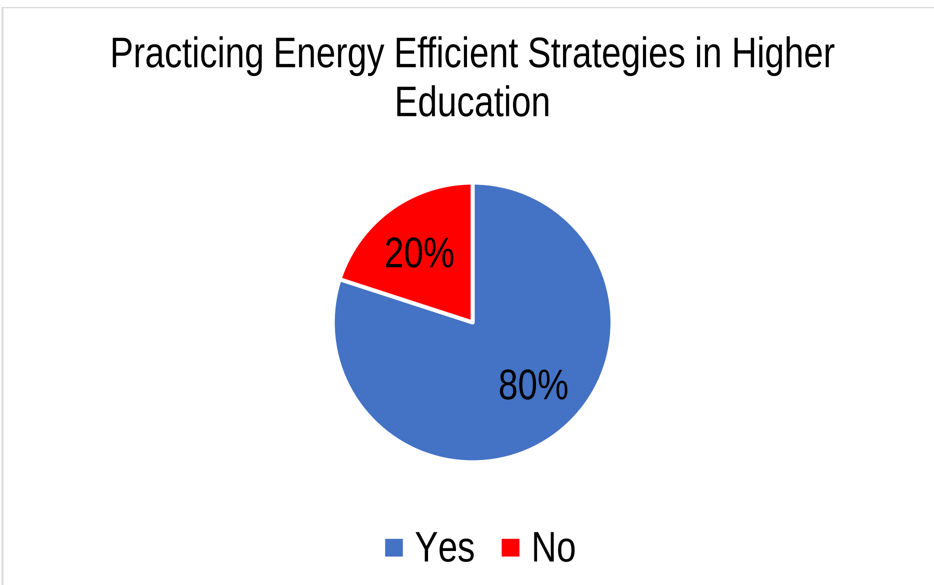
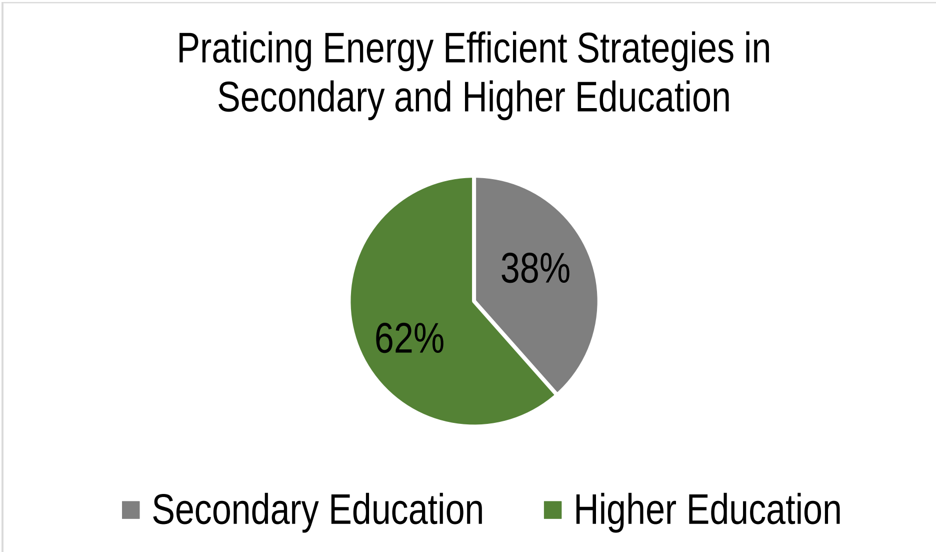


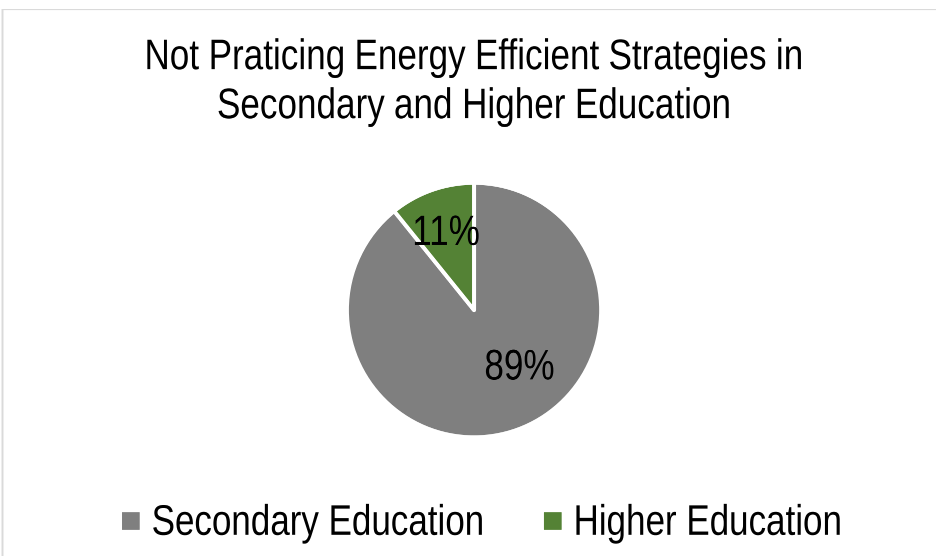
Table 28 shows students practicing energy efficient strategies who learned them in Higher Education compared to those who are practicing and learned them in Secondary Education.

Table 28 Practicing Energy Efficient Strategies in Secondary Education Vs. Higher Education



Results show that 62% of students who learn about energy efficient strategies in higher education are actually practicing them as opposed to 38% of secondary education students who are practicing energy efficient strategies. Table 29 shows students not practicing energy efficient strategies who learned them in Higher Education compared to those who are not practicing and learned them in Secondary Education.

Table 29 Not Practicing Energy Efficient Strategies in Secondary Education Vs. Higher Education



Results show that 89% of students who learned about sustainability action in Secondary Education are not practicing energy efficient actions. These results are critical because it is showing that most students in secondary education are not practicing energy efficient strategies when compared to students in higher education.

In terms of water usage, 31% answered that they tend to practice water efficient strategies. These strategies were learned in Secondary Education and 69% don't practice them as illustrated in Table 30.

Table 30 Students Practicing Water Efficient Strategies in Secondary Education

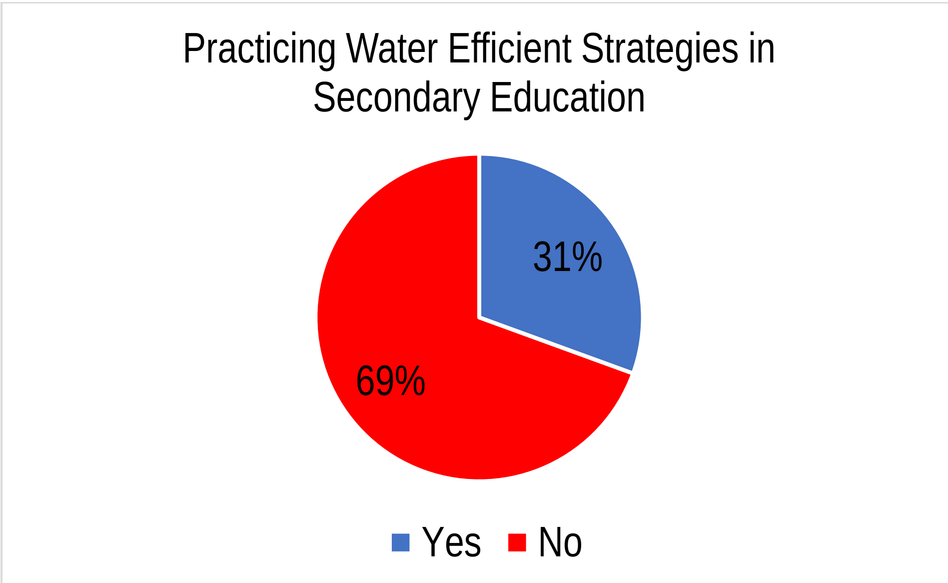


Table 31 explains how 79% of students who learned about water efficient strategies in higher education are practicing pro-sustainable actions.

Table 31 Students Practicing Water Efficient Strategies in Higher Education

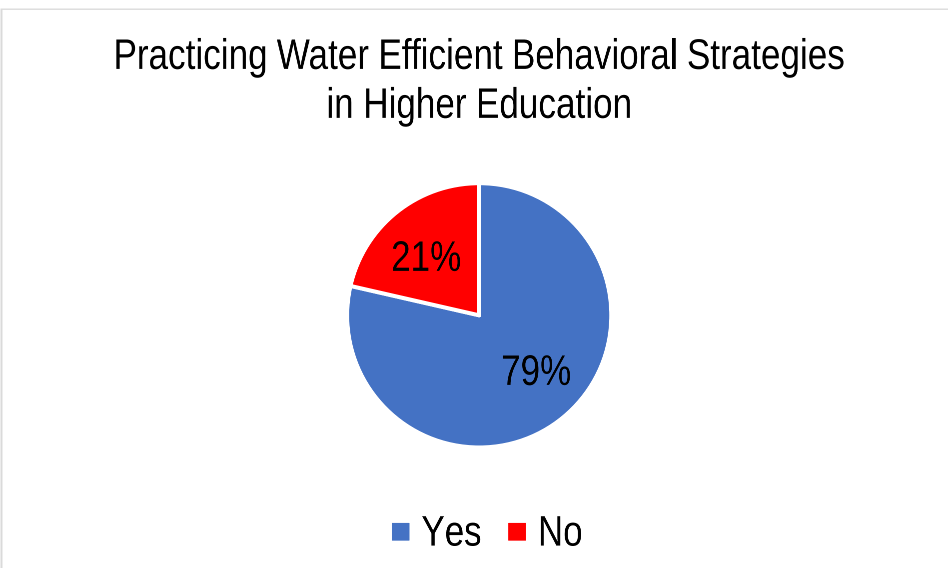
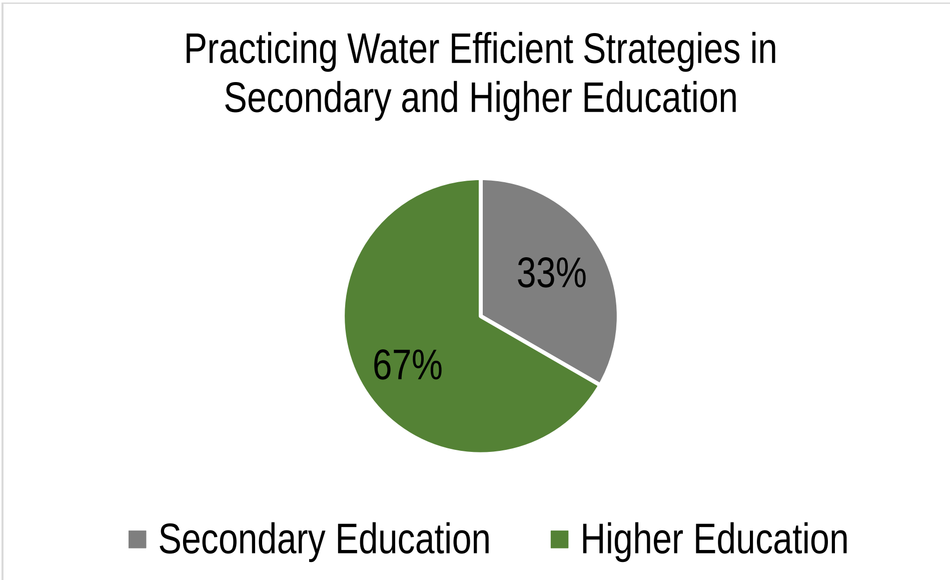


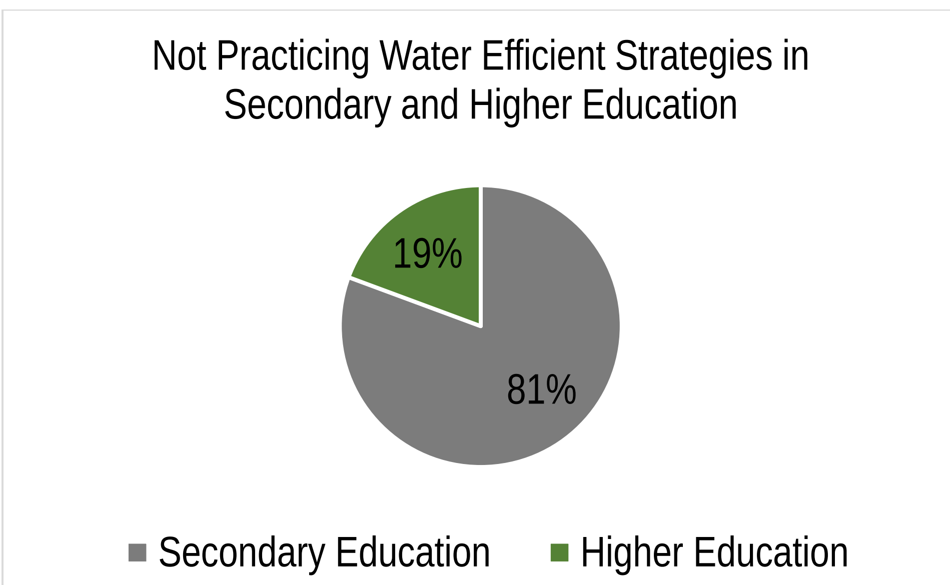
Table 32 shows students practicing water efficient strategies who learned them in Higher Education compared to those who are practicing and learned them in Secondary Education.

Table 32 Practicing Water Efficient Strategies in Secondary Education Vs. Higher Education



Results show that 67% of students who learn about water efficient strategies in higher education are actually practicing them as opposed to 33% of secondary education students who are practicing water efficient strategies. Table 33 shows students not practicing water efficient strategies who learned them in Higher Education compared to those who are not practicing and learned them in Secondary Education.

Table 33 Practicing Water Efficient Strategies in Secondary Education Vs. Higher Education



Results show that 81% of students who learned about sustainability action in Secondary Education are not practicing water efficient actions. These results are critical because it is showing that most students in secondary education are not practicing water efficient strategies when compared to students in higher education.

In terms of waste output, 27% answered that they tend to practice waste efficient strategies. These strategies were learned in Secondary Education and 73% don't practice them as illustrated in Table 30.

Table 34 Students Practicing Waste Efficient Strategies in Secondary Education

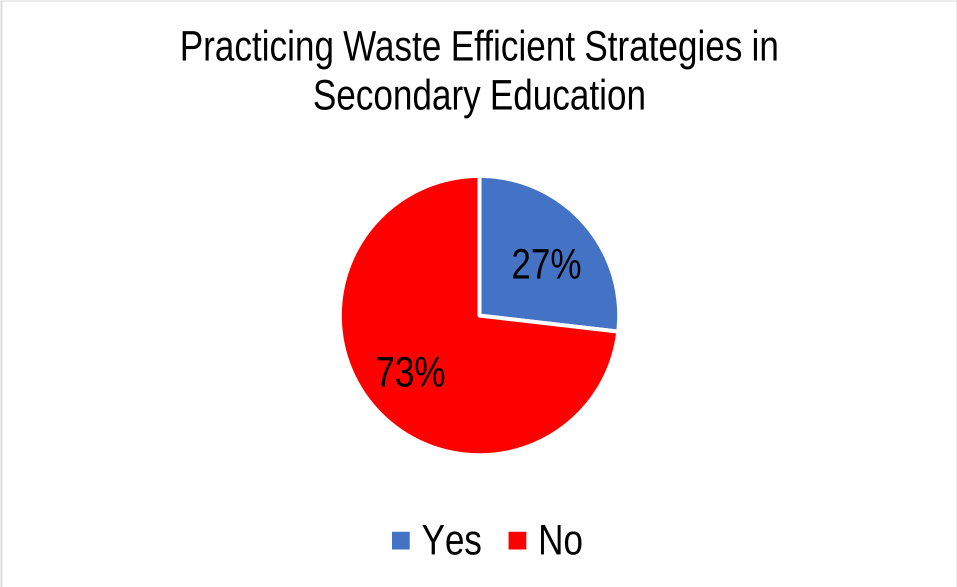


Table 35 explains how 76% of students who learned about waste efficient strategies in higher education are practicing pro-sustainable actions.

Table 35 Students Practicing Waste Efficient Strategies in Higher Education

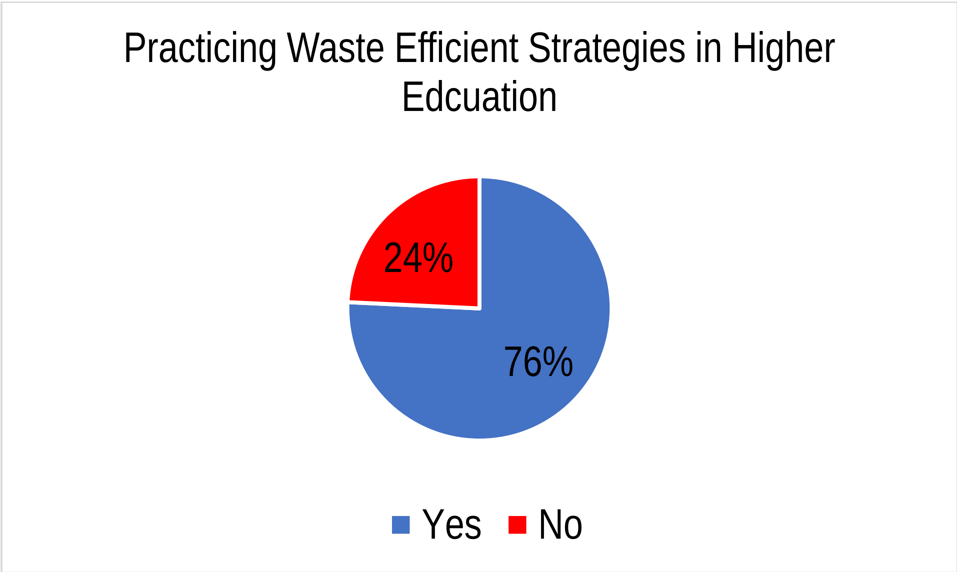
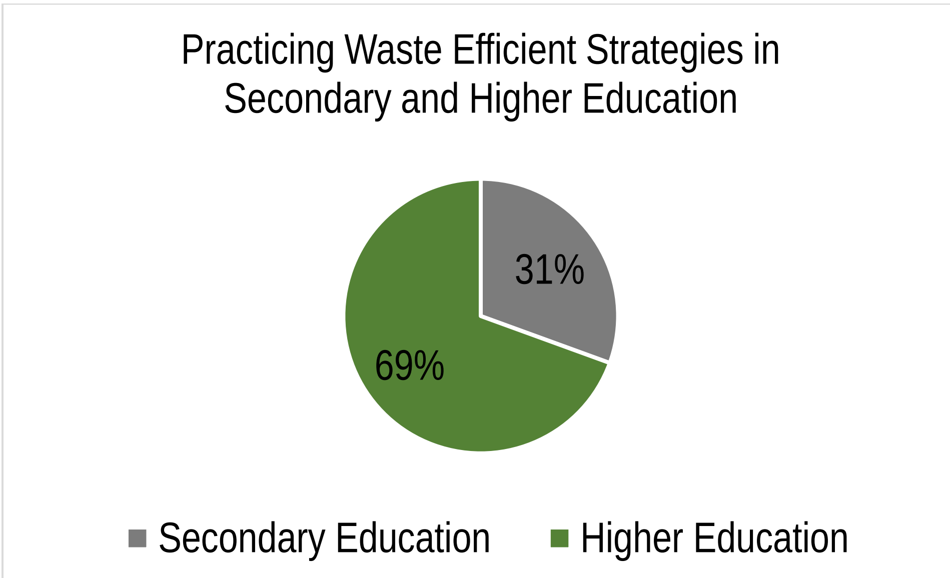


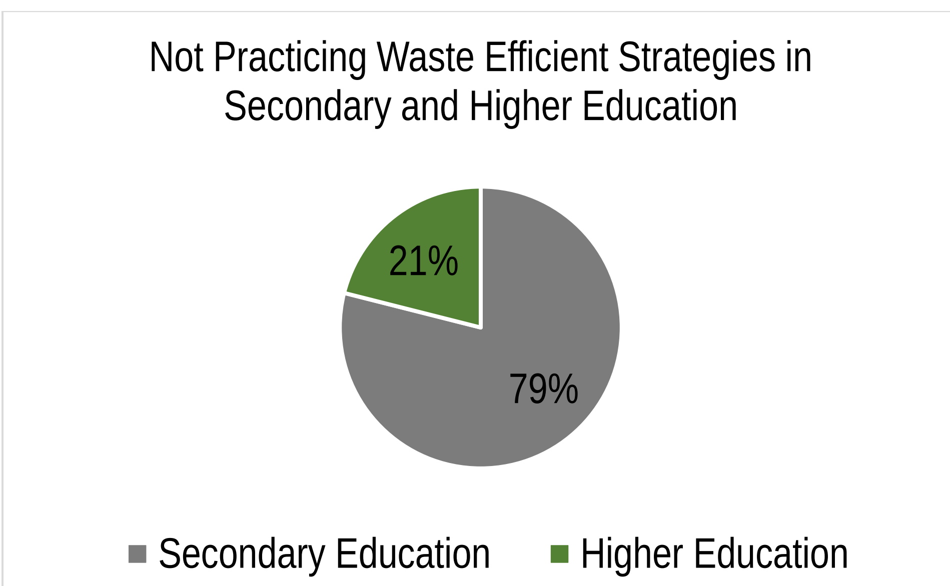
Table 36 shows students practicing waste efficient strategies who learned them in Higher Education compared to those who are practicing and learned them in Secondary Education.

Table 36 Practicing Waste Efficient Strategies in Secondary Education Vs. Higher Education



Results show that 69% of students who learn about waste efficient strategies in higher education are actually practicing them as opposed to 31% of secondary education students who are practicing waste efficient strategies. Table 37 shows students not practicing waste efficient strategies who learned them in Higher Education compared to those who are not practicing and learned them in Secondary Education.

Table 37 Practicing Waste Efficient Strategies in Secondary Education Vs. Higher Education



Results show that 79% of students who learned about sustainability action in Secondary Education are not practicing waste efficient actions. These results are critical because it is showing that most students in secondary education are not practicing waste efficient strategies when compared to students in higher education.

In terms of carbon emission, 19% answered that they tend to practice carbon emission efficient strategies. These strategies were learned in Secondary Education and 81% don't practice them as illustrated in Table 38.

Table 38 Students Practicing Carbon Emission Efficient Strategies in Secondary Education

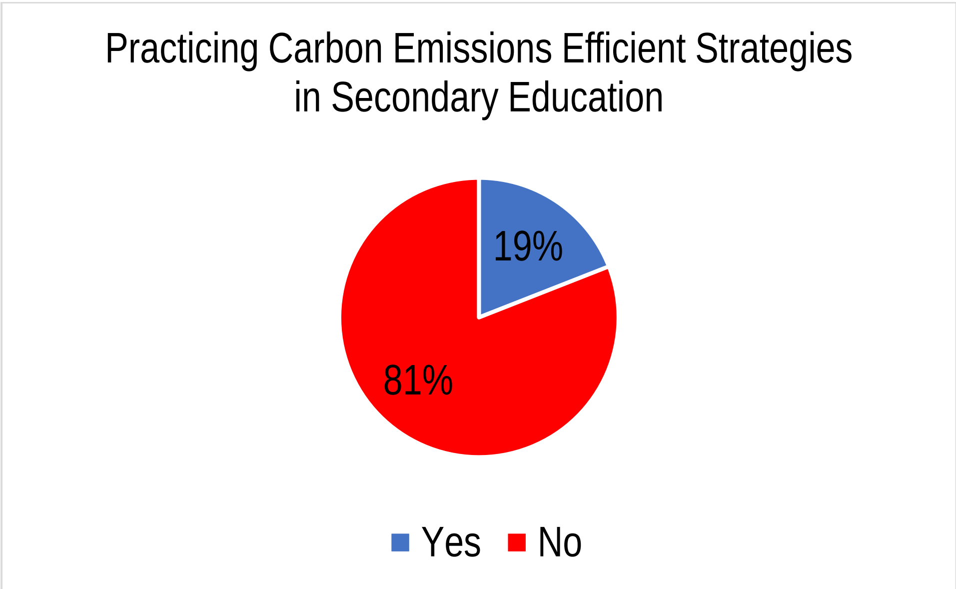


Table 39 explains how 82% of students who learned about carbon emission efficient strategies in higher education are practicing pro-sustainable actions.

Table 39 Students Practicing Carbon Emission Efficient Strategies in Higher Education

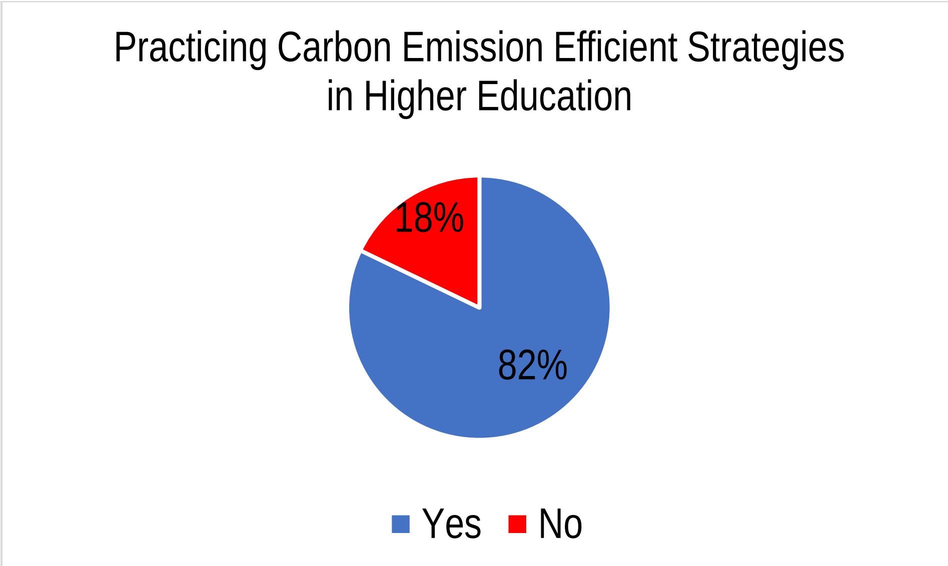
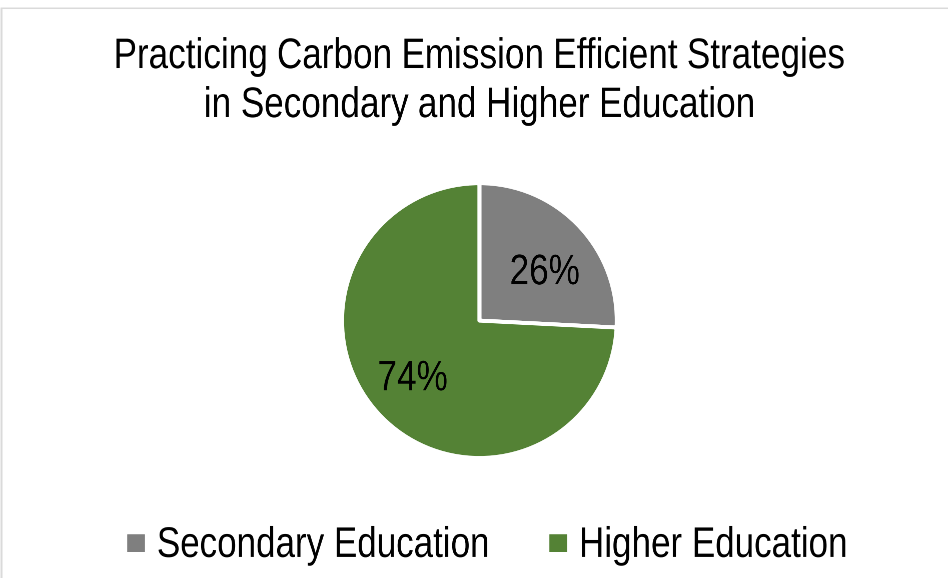


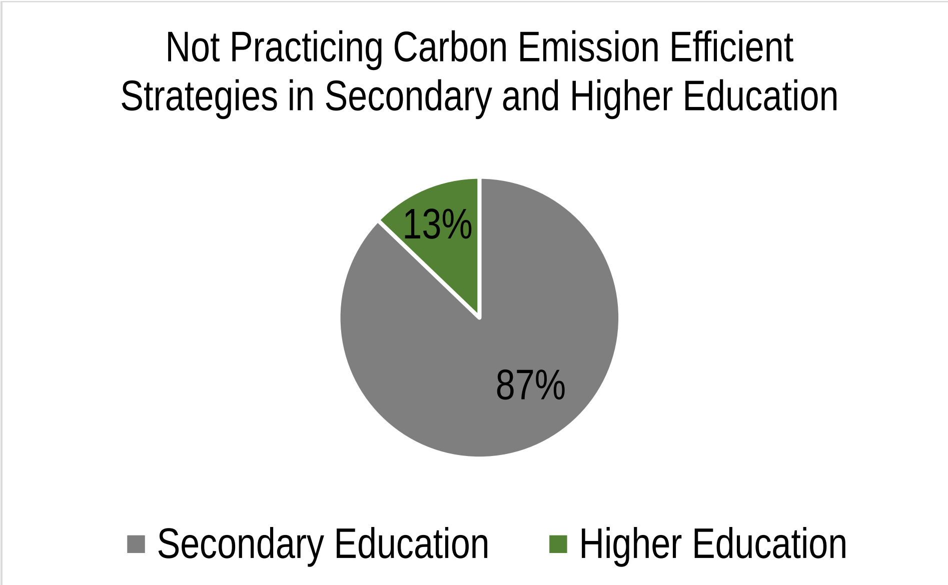
Table 40 shows students practicing carbon emission efficient strategies who learned them in Higher Education compared to those who are practicing and learned them in Secondary Education.

Table 40 Practicing Carbon Emission Efficient Strategies in Secondary Education Vs. Higher Education



Results show that 74% of students who learn about carbon emission efficient strategies in higher education are actually practicing them as opposed to 26% of secondary education students who are practicing energy efficient strategies. Table 41 shows students not practicing carbon emission efficient strategies who learned them in Higher Education compared to those who are not practicing and learned them in Secondary Education.

Table 41 Not Practicing Carbon Emission Efficient Strategies in Secondary Education Vs. Higher Education



Results show that 87% of students who learned about sustainability action in Secondary Education are not practicing carbon emission efficient actions. These results are critical because it is showing that most students in secondary education are not practicing carbon emission efficient strategies when compared to students in higher education.

The survey conducted demonstrated that even though most students are sustainable in some ways, most students have acquired this pro-sustainable behavioral personal lifestyle through higher education. These findings infer that even though most students are aware of sustainability, it does not correlate with sustainability actions to the issue of the gap between theory and practice in education. It also leads to the issue of Secondary Education students whom are aware of sustainability but don't practice sustainable actions. These results lead to a critical change in Secondary Education institutions to teach more about sustainability and branch further than just teaching about sustainability awareness. Students at this age should engage and practice sustainability actions in their curriculum.

Methodology

1.1 Introduction

Sustainability Education must exist in all levels of society. To create a sturdy foundation in the subject, sustainability should be taught in all levels of education targeting its four personnel bodies whom are students, faculty, staff and alumni with the most important level being high school since it is the age where most habits are made and gives a foundation to continue to higher education institutions. Today, sustainability education is mostly being taught in higher education. By then, most students have their own values and ways of life. If sustainability education were to be taught earlier on in the high school level. More students will continue to make sustainability conscience decisions in their future education and careers.

The sustainability toolkit is being applied in High Schools because of the existing gap between theory and practice. At this age, students are most prone to creating life-lasting habits that will transpire into either higher education or their career after High School if chosen to opt out of acquiring Higher Education. High School students who opt out of Higher Education can have effective sustainability in their careers whether they work at a McDonald’s or a Beauty Salon. Not everyone goes to college which is why sustainability education in High School students is critical. Out of the total students enrolled in High School in the United States, 1.2 million of them drop out yearly (Miller, 2015). Sustainability education can have a potential of increasing higher education enrollments.

1.2 Levels of Sustainability Education

There are four levels of sustainability that will be defined in this section. These levels are made up of Level 1: Awareness, Level 2: Understanding, Level 3: Performing/Application, and Level 4: Mastery as demonstrated below.

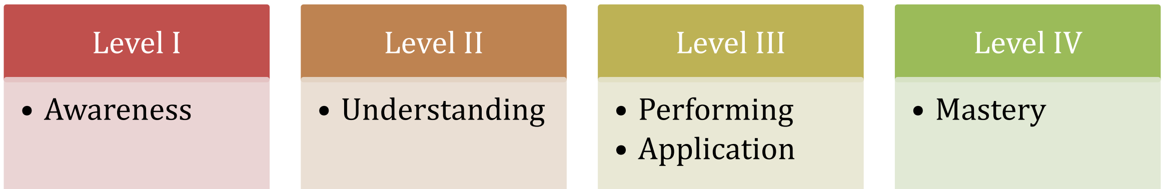


Figure 4 Four levels of sustainability education

Since companies have increased demand in implementing sustainability actions in their endeavors, young professionals should be adequately educated in the topic. The four levels of sustainability education are explained in the following sections.

Level 1: Awareness

Sustainability awareness in this paper is a combination of what an individual knows about in order to foster action by recognizing the important role actions play in environmental issues today. Sustainable awareness that fosters action is an approach towards provoking change in an individual's actions through behavior-change strategies. Awareness is the first level because many students know about sustainability and are interested in knowing more about sustainability. Although, most people don't think their daily activities will affect the environment which is why at this level many people do not act on their knowledge.

Level 2: Understanding

During level 2, a student should have a substantial amount of sustainability understanding. Level 2 sustainability understanding is comprised of what a student should know about, be able to identify, critically evaluate, and do. It is also crucial to establish the broad role of sustainability within society in this level. Students should be required in their high school education to develop the ability to understand sustainability and the need for it to be able to integrate it socially, environmentally, and economically in their decision making. When sustainability is implemented in a curriculum, students will learn cognitive knowledge about to be able to translate into the next level of performance and application. To complete an understanding level, students must be provided with sustainability courses in their curriculum to address sustainability issues through basic cognitive knowledge. This level can only be completed if there is previous learning or awareness of the fact to be able to develop and effective deeper understanding.

Level 3: Performing/Application

For students to perform cognitive actions, they must have completed the awareness and understanding level. There is a need for students to translate their sustainability knowledge into actions.

Level 4: Mastery

It is critical for students in the mastery level to be able to challenge and provide opportunities do develop a set understanding of complexities of sustainability. These students have mastered all the levels to the point where they are able to act on their knowledge from education into a systematic critical way.

Conclusion

These four levels of understanding work as a linear path towards sustainability competency. Sustainability competency is only gained through knowledge of facts attained through education and experience to develop a deeper understanding and be able to act on their knowledge. For students to act on pro-environmental actions, they must have at least the three levels of sustainability education which is awareness, understanding, application and performance. In these four levels of understanding, High Schools are only going through Level I of Sustainability Education as illustrated in Figure 16.

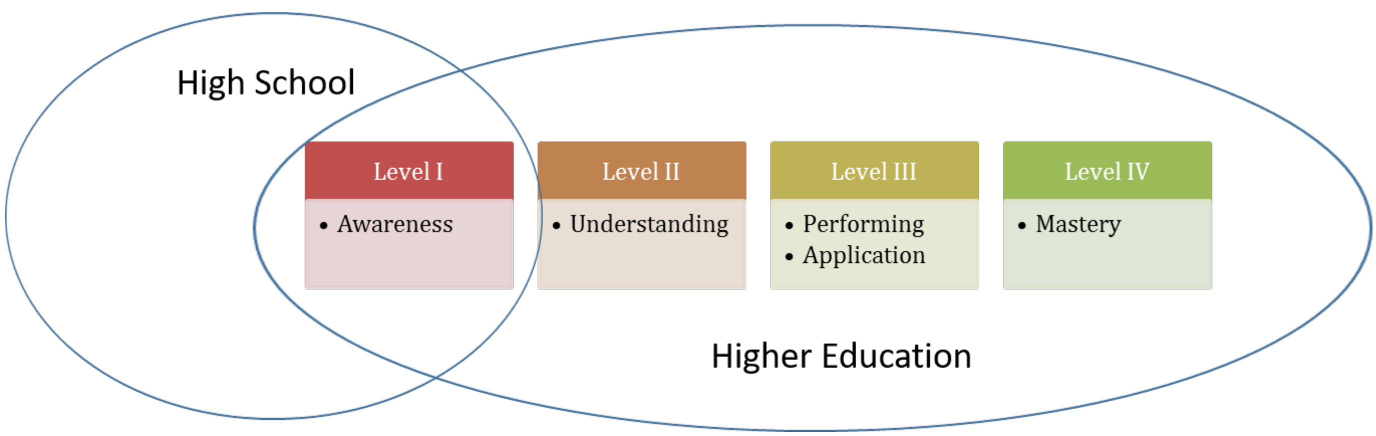


Figure 5 Existing Levels of Sustainability Education incorporated in Educational Institutions

Based on the curriculum in High School Science that incorporates sustainability, it only covers level one of sustainability education which is awareness. Since studies have found that awareness does not correlate to sustainability actions, a different approach must be created. This approach is explained in the following sections.

1.3 Sustainability Toolkit

In response to the study of behavior-based strategies being implemented to learn about sustainability, this research is based on the implementation of behavior-based strategies in High School to educate and instill sustainability habits on the institution's four personnel bodies whom are students, faculty, staff and alumni. These sustainability metrics will be based on these four factors:

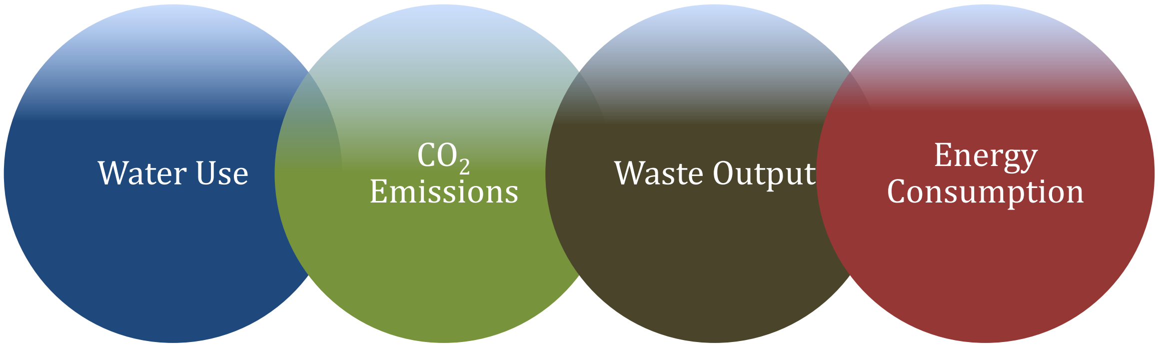


Figure 6 Four Factors in Sustainability Toolkit

The four factors in sustainability each consist of different levels is sustainability education which is explained in the following table.

Table 42 Levels of Sustainability Education within four sustainability factors

	Levels of Sustainability			
Sustainability Factor	Level 1	Level 2	Level 3	Level 4
Water Use	Aware of the amount of water being used and its effects	The ability to understand that water is a resource.	The application of awareness and understanding into water saving methods.	Mastery in water saving methods with the ability to educate as well as innovate water use elements.
Waste Output	Aware of the amount of waste output and its effects	Ability to understand why reducing waste ouput is important	The application of awareness and understanding into reducing waste output	Mastery in reducing waste output with the ability to educate and innovate waste output elements
CO2 Emissions	Aware of the amount of CO2 Emissions and its effects	Understands why CO2 emission reductions is important	The application of awareness and understanding into reducing CO2 Emissions	Mastery in reducing CO2 Emissions with the ability to educate and innovate CO2 emission elements
Energy Consumption	Aware of the amount of Energy Consumption and its effects.	Understands why reducing energy consumption is important	The application of awareness and understanding into energy efficiency	Mastery in reducing energy consumption with the ability to educate and innovate ennergy consumption elements

The proposed behavior-based strategies are meant to reduce Water Usage, CO2 Emissions, Waste Output, and Energy Consumption in the institution's four personnel bodies made up of students, faculty, staff and alumni without making any enhancements to the building leaving it as-is. Throughout the paper, behavioral sustainability methods meant to reduce these four factors will be called BSM's that stand for Behavioral Sustainability Methods. The strategies imposed on their institution will be quantified its monthly utility bills. As utility bills reduce, money saved can be invested into active strategies to further reduce these four factors such as sensors, improved HVAC systems, cisterns, etc. This money can also be invested in faculty wages, student scholarships, educational fieldtrips, and funding sustainability projects.

1.2.1 Water Use

The earth is made up of 97% of ocean while only 3% is drinking water. Even though it may seem like there is an abundant availability of water, many dessert communities lack these essential amenities. Some people might say that diamonds or gold are the most valuable luxury one can own but water is the world's most precious commodity. The use of water worldwide is exponentially increasing. Due to the increase of water consumption, a water crisis has arisen around the world. The United States in particular has increased water consumption drastically due to the use of water becoming a necessity other than a luxury, as it would be in other countries. World water consumption is divided into three sectors: 1) agriculture amounting to the most water usage, 2) industry, and 3) domestic as illustrated in Figure 18.

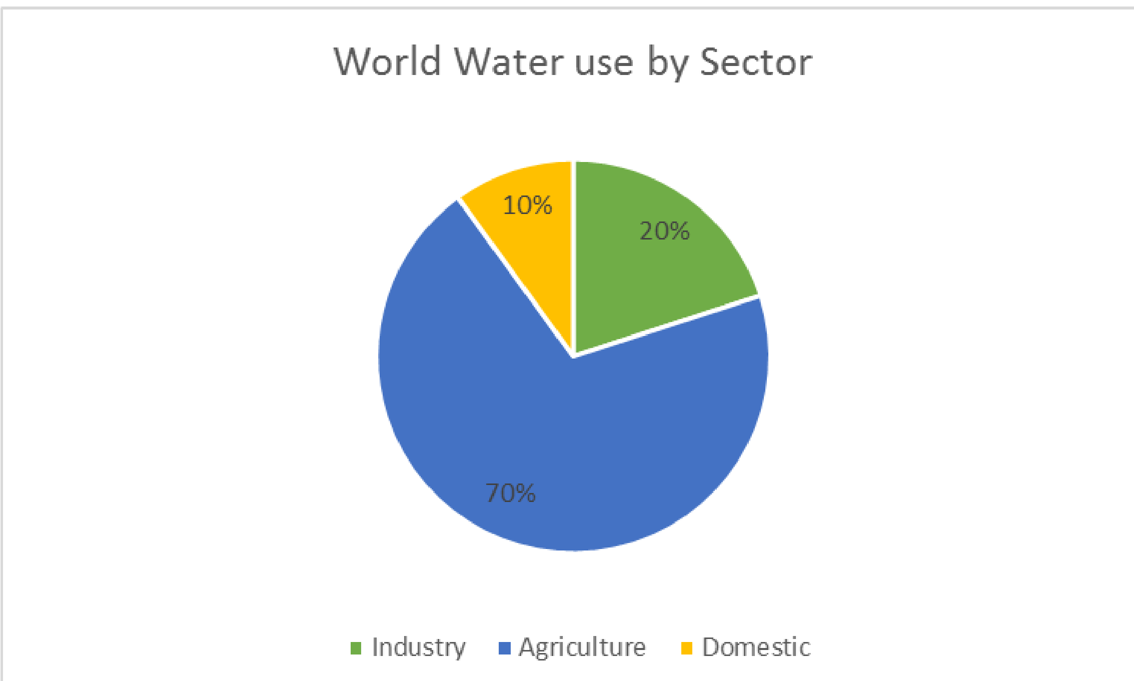


Figure 7 World water use by sector

Many different factors contribute to the world's water crisis such as water pollution from heavy metals, industrial waste, microbial products, and the accessibility of water due to water supply, drought, and its high demand. The water crisis worldwide has led to a continuous consciousness and combined effort to reduce water consumption as well as harvest water. Since cost correlates with water consumption, water-saving practices are critical to reduce water consumption.

Water Reduction

The reduction of water usage is crucial to fixing the overall water consumption. Reduction of water usage can be done through wide scales such as worldwide, nationwide, urban, rural, building, commercial, and single family homes. There are many ways to reduce water such as using water efficient fixtures, time of use, xeriscaping, by behavior, and many other strategies.

Water reduction must be taken into consideration before implementing water-harvesting strategies: we reduce first. Reducing water usage is essential for every building particularly in arid regions where water is a valuable resource and drought conditions are expected. There are two ways to reduce water. One is through behavior such as reducing water use through the individual's regular routine. This can be through hygiene such as turning off the faucet while brushing one's teeth, showering faster, and replacing showerheads to low flow showerheads. One's behavior should be pushed towards reducing water in their regular everyday routines. There are also other examples of reducing water. For example, a cheap way to reduce water consumption in toilets would be to displace enough water out of the toilet in the tank and add a brick to it. This allows the same pressure to flush and reduces the amount of water used per flush. Having native plants in the landscape as well as salt tolerant plants is also an efficient way to reduce water use outdoors. Having an efficient irrigation system can also save a lot of water.

Water Harvesting

Water harvesting can be achieved in many different ways. Capturing, slowing, and treating storm water are the main components of water harvesting. Water can be harvested by the use of rain gardens and water catchment systems. Only after water usage is reduced through water efficiency strategies and behavior, water harvesting can be implemented. Water harvesting is the storage of water to have the capability to re-use. Water harvesting is a great sustainable strategy to be able to re-use the water that would normally be wasted. Harvested water can be used as gray water to supply sinks, toilets, showers, and washing machines. It can also be used to irrigate plants or create a microclimate to cool a space. Water harvesting is extremely beneficial in every climate since water is needed worldwide. There are many different types of water harvesting strategies. One example of a water harvesting strategy is using a cistern to store water from a rain gutter system that is channeled through the catchment roof into the storage tank. This type of strategy is easy to calculate and implement. The harvesting of water implemented from a rain gutter system to a cistern is shown in Figure 19.

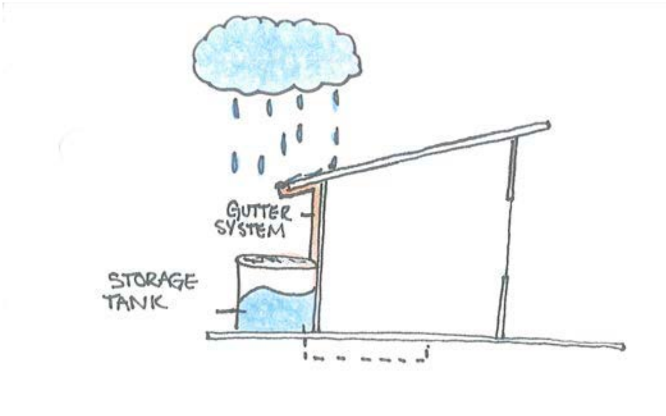


Figure 8 Example of Rainwater Harvesting Using a Cistern

Another strategy to harvest water is using a cistern but to implement it underground. This helps to keep the water cool and to also reduce the evaporation of the water while it is harvested. A sketch of this strategy is shown in Figure 20.

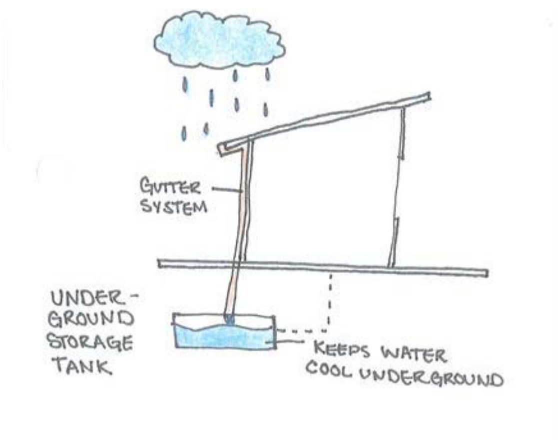


Figure 9 Example of Rainwater Harvesting Using an Underground Cistern

If the budget for the project is low or the client simply does not want the use of cisterns and just wants to use harvested water for irrigation, swales are the best options. Swales are scars made to the grown where vegetation is inserted in as well as rocks to slow the water in the swale. This strategy is ideal to slow down water and retain it for vegetation's use longer. An example of a swale is shown in Figure 21.

Figure 10 Example of Rainwater Harvesting Using Swales

Another strategy for irrigation that can be implemented in the residential scale is to create basins in between residencies and walkways. It has a similar effect as swales in respect to slowing down water to retain it for a longer amount of time as seen in Figure 22.

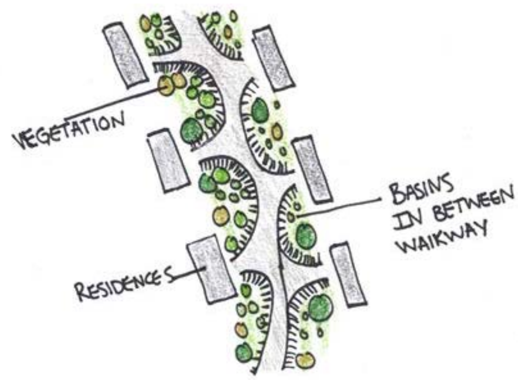


Figure 11 Example of Rainwater Harvesting Through the use of Swales

A rainwater harvesting strategy that can be implemented in the city scale is to open sidewalks to the rode so that the water that is flowing through road can also harvest water into the sidewalk through small swales that can be created to capture the water longer. This strategy can be seen in Figure 23.

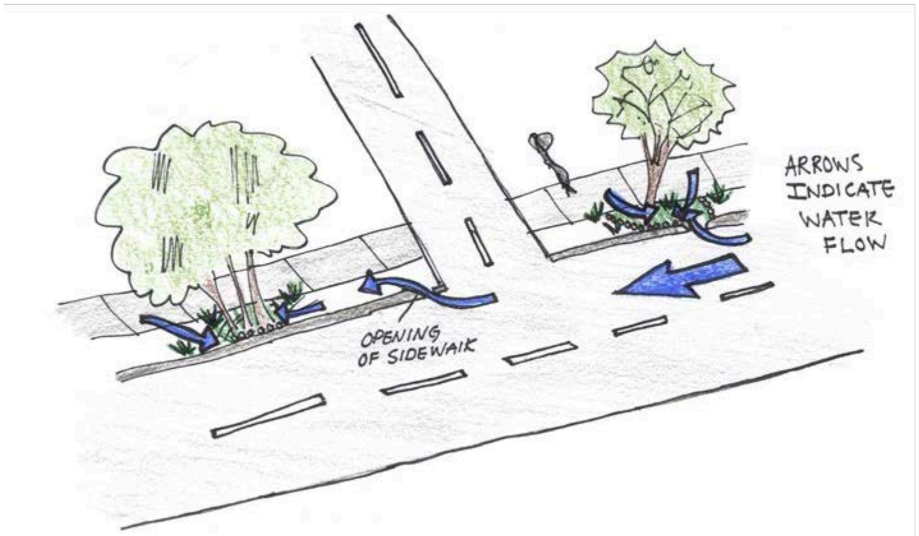


Figure 12 Rainwater Harvesting Strategy with Basins In between Walkways

It is extremely important to be aware of the amount of water each plant needs for irrigation during the implementation of water harvesting strategies. Especially in an arid region where there is little rain throughout the year, knowing what kinds of plants need the specific amount of water that's going to be harvested is critical for this strategy to work correctly. The following figure shows vegetation types in the Sonoran Desert as well as other information such as size, type of leave, and amount of water needed per year as shown in the Table 43.

Table 43 Table of Xeriscape Vegetation Types in the Sonoran Dessert

Xeriscape in the Sonoran Desert				
Vegetation Type	Average Size (Ft. + in.)	Leaves	Water	Soil
Saguaro	20-50 ft.		8 in. per year	Rocky, Well Draining
Ocotillo	6-15 ft.		8 in. per year	Rocky, Well Draining
Brittlebush	2-4 ft tall and wide		8 in. per year	Sandy, Rocky, Well Draining
Organ Pipe Cactus	2-6 ft in diameter		8 in. per year	Adaptable, Well Draining
Engelmann Prickly Pear	3-7 ft			Sandy, Well Draining
Teddybear Cactus	5-8 ft			Sandy, Well Draining
Mesquite	15-30 ft	Decidious in cold	8 in. per year	Adaptable, Well Draining
Chainfruit Cholla	3-15 ft			Sandy, Well Draining
Gold Poppies	6-8 in.		6-8 in per year	Adaptable, Well Draining
Elephant Tree	up to 30ft	Decidious in cold		
Rosewood	6-20 ft	evergreen	12 in. per year	Adaptable, Well Draining
Juniper	2-6 ft	evergreen	drought tolerant	Adaptable, Well Draining
Palo Verde	15-25 tall and wide	decidious in cold	8 in. per year	Sandy, Well Draining
Cholla Staghor	3-15 ft			Sandy, gravelly, well draining

Water Catchment Systems

Water catchment systems such as cisterns revert water from roof and incoming rain providing clean water and reducing storm water runoff. This water can be used for potable water supplies as well as landscaping. It is important to have effective filtration and disinfection methods to guarantee the quality of the water. Rain gardens divert, slow, and filter storm water runoff from parking areas. A great example of a rain garden is seen at the College of Architecture, Planning, and Landscape Architecture's Underwood Garden seen in Figure 24.

Figure 13 College of Architecture, Planning, and Landscape Architecture Rain Garden. Taken by Ambar A. Gardner

Behavioral Applications to Reduce Water Usage

Table 44 Behavior-based strategies for water usage

Application	Impacts	Daily Reductions (Gallons)	Annual Reductions (Gallons)	Effort	Cost
Irrigate in Need-only basis	3	Varies	Varies	2	Saving
Opt out of taking baths	2	12/per person	4,380/per person	1	Saving
Turn off water while brushing teeth	2	8/per person	2,920/per person	2	Saving
Turn off water while washing hands	2	6/per person	2,190/per person	2	Saving
Turn off water while shaving	2	12/per shave	Varies	2	Saving
Turn off water while washing dishes	2	Varies	Varies	2	Saving
Turn off water while showering	2	Varies	Varies	2	Saving
Take Shorter Showers	2	Varies	Varies	2	Saving
Maximizing Washer Loads	2	Varies	Varies	2	Saving
Maximizing Dishwasher Loads	2	Varies	Varies	2	Saving
Use refillable water stations	2	Varies	Varies	2	Saving
Time of use - Irrigation	2	Varies	Varies	2	Saving
Use Dishwasher Vs. Hand Washing	2	16/per wash	5,840/based on 1 wash daily	2	Saving
Use water fountains correctly	1	Unknown	Unknown	2	Saving
Reusing worn clothes	1	Varies	Varies	2	Saving
Put a plastic bottle filled with water in your toilet tank	1	Varies	Varies	3	Saving

Technical Applications to Reduce Water Usage

Table 45 Technical applications to reduce water usage

Application	Impacts	Daily Reductions (Gallons)	Annual Reductions (Gallons)	Effort	Cost (Economic Brand)
Cisterns	3	25 based on a 2,500 ft2 roof	9,125	3	$739.95
Retrofit Water Filling Station				4	$435.54
Maintenance Irrigation System				3	Varies
Community Garden				5	Varies
Water Catchment Systems				4	Varies
Swales				5	Varies
Water Saving Technologies				2	Varies
Low-Flow Toilet		5 per flush	1,825 per flush	2	Varies
Water Saving Heads		15/per person	5475/per person	2	20$
Water Sensors				2	
Fixing Leaks		20/day (sink faucet)	7,300 (sink faucet)	3	
Low-Flow Fixtures				2	
Insulated Water Pipes				4	
Xeriscaping				4	
Advanced Dripping Systems				4	
Low-Flow Faucet Aerators				2	

1.2.2 Waste Output

Material wealth in the United States has become extremely important in the 20th century with the continued consumerist culture. The human needs are simple: people need shelter, water, clothing, and food. What people want and what they actually need is substantially different based on the US consumerist culture. In terms of school waste, Back-to-School shopping based on the US Census amounts to $7.4 billion as well as $2.2 billion in bookstores (U.S Census, 2010). Material ecology seems to be one of waste. The average American will throw away 600 times the amount of their weight in garbage over their lifetime according to the EPA. An adult weighing 150 pounds, this equates to around 90,000 pounds of trash. Breaking norms are difficult, therefore an economic incentive for someone to practice waste management and recycling is vital. Having recycling bins in every room, hallway, and outdoor space is essential for a clean and renewable environment. It is important to have a system to transport the recyclables to a recycling station. Waste processing and disposal systems are essential to have.

Behavioral Applications to Reduce Waste Output

Table 46 Behavioral strategies to reduce waste output

Behavioral Applications to Reduce Waste Output		
Application	Impacts	Effort
Recycle	Reduce Waste Output	3
Opt out of using plastic non-reusable bottles	Reduce Waste Output	1
Limit Pesticides	Reduce Waste Output	2
Reduce Demand for Consumer Plastic	Reduce Waste Output	3
Compost	Reduce Waste Output	4
Utilize biodegradable paper and packaging	Reduce Waste Output	2
Reduce Printing	Reduce Waste Output	2
Use Reusable Grocery Bags	Reduce Waste Output	3
Reysing Materials	Reduce Waste Output	2

Technical Applications to Reduce Waste Output

Table 47 Technical Strategies to reduce waste output

Technical Applications to Reduce Waste Output		
Application	Impacts	Cost
Recycling Program	Reduce Waste Output	Varies
Conduct Waste Audits	Reduce Waste Output	Varies
Upcycling Operations	Reduce Waste Output	Varies
Recycle - Re-use building materials	Reduce Waste Output, Reduce Energy Consumption	Varies

1.2.3 CO_2 Emissions

The burning of fossil fuels, solid waste, trees and wood products, and also as a result of certain chemical reactions are how carbon emissions are emitted into the atmosphere. The United States is well known for its consumerist culture leading in carbon emissions globally. Ironically, the United States also leads in Green Building Design. The discrepancy between both topics starts an issue of behavior. Buildings account for 39% of total carbon emissions. Building innovations are essential to the reduction of energy use and greenhouse gas emissions in the building sector (Athienitis, O'Brien, 2015). The increase in greenhouse gas emission also increase the demand for behavioral change in buildings across the United States. Therefore, the integration of behavioral strategies, passive design, energy efficiency strategies, and conservation measures along with renewable energy sources of heat and electricity are vital towards achieving pro-environmental action to increase urban sustainability by reducing CO_2 emissions.

The resourcefulness of the building is an important factor in the school's overall efficiency. The building's walkable location and proximity to public transportation can reduce the carbon footprint of vehicles driving there every day. Automobile parking spaces are also essential in the productivity of a building, especially a school. A school's building must have a safe place for bicycle, skateboard, and scooter storage to encourage these types of transportation. The use of regional materials in the building will also dramatically reduce the total carbon footprint used to build and maintain the building. Another way to be resourceful is to lower the indoor comfort temperature at night to reduce energy consumption (night flush ventilation).

Serving healthy food schools is essential for an overall pleasing education. Eating healthy can benefit a student tremendously when it comes to concentrating and having enough energy to function throughout a school day. If a community garden is implemented in the school, the food grown can be implemented in the school lunch menu and also save the carbon footprint it takes to transport food from outside vendors. This initiative can increase Biobased products that are derived from plants to provide an alternative to petroleum derived products.

Behavioral Applications to Reduce CO_2 Emissions

Table 48 Behavioral strategies to reduce CO_2 emissions

Behavioral Applications to Reduce Co2 Emissions		
Application	Impacts	Effort
Travel Less	Emissions Reduction, Reduced Air Pollution	3
Carpool	Emissions Reduction	3
Bicycle	Emissions Reduction	3
Reduce Vehicle Use	Emissions Reduction	4
Use Public Transportation	Emissions Reduction	3
Buy Local	Emissions Reduction	3
Walk more	Emissions Reduction	3
Eat organic	Emissions Reduction	3
Bike Sharing	Emissions Reduction	4

Technical Applications to Reduce CO_2 Emissions

Table 49 Technical strategies to reduce CO_2 Emissions

Technical Applications to Reduce Co2 Emission		
Application	Impacts	Cost
Electric Car	Emissions Reduction	Varies

1.2.2 Energy Consumption

Energy efficiency is important for reducing carbon emissions. Buildings account for 41% of energy consumption and 74% of electricity consumption in the United States, while accounting for 39% of carbon emissions. The United States is well known for its consumerist culture leading in carbon emissions globally, BUT it also leads in Green Building Design. Scientists, researchers and politicians are primarily concerned with the impact of climate change on our future, which has brought to the forefront the issue of sustainability and energy conservation. Scientists and researchers focus their studies around the common building structures either commercial and/or residential. Since traditional buildings are responsible for about 40% of the total fossil energy consumed in the United States, both designers and building occupants are interested in long-term savings and energy efficiency (Maclay, 2014).

Energy costs are extremely high in educational institutions. These costs are comprised of the biggest operational cost after personnel (Energy Efficiency Programs in K-12 Schools, 2016). Energy is a huge driver in a school's management and learning environment there are multiple accommodation needs such as indoor air quality and lighting that must be met. Thus, the EPA estimates that 25% of energy use in schools is wasted (Energy Efficiency Programs in K-12 Schools, 2016). A focus on the school's building operations is fundamental to save energy to fund educational resources that would be spent on utility bills. Energy expenses are commonly seen as relatively fixed expenses when they can easily be reduced. However, there is acquired interest in behavior-based initiatives to reduce energy consumption in schools considering that people spend 90% of their time indoors. Achieving energy reductions through behavior in buildings respond to the challenge of urban sustainability. Since the urban population accounts for more than 50% of humanity, urban sustainability cohesively correlates to the behavioral approach to energy reduction strategies (Satterthwaite, 2011).

Behavioral Applications to Reduce Energy Consumption

Table 50 Behavioral strategies to reduce energy consumption

Behavioral Applications to Reduce Energy Consumption		
Application	Impacts	Effort
Turn Lights off when not in use	Energy Reduction, Emissions Reduction	2
Unplug Appliances when not in use	Energy Reduction, Emissions Reduction	2
Reduce use of heated water	Energy Reduction, Emissions Reduction	3
Reduce use of Appliances	Energy Reduction, Emissions Reduction	3
Reduce Heating/Cooling Demand	Energy Reduction, Emissions Reduction	3
Reduce Appliance Ownership	Energy Reduction, Emissions Reduction	3
Keep doors and windows clothes when heater/cooler on	Energy Reduction, Emissions Reduction	2
Maximizing Dryer Load	Energy Reduction, Emissions Reduction	2
Air Dry Clothes	Energy Reduction, Emissions Reduction	3
Reusing Worn Clothes	Energy Reduction, Emissions Reduction	2
Opt out of Using Elevator (Need-only basis)	Energy Reduction, Emissions Reduction	2

Technical Applications to Reduce Energy Consumption

Table 51 Technical applications to reduce energy consumption

Technical Applications to Reduce Energy Consumption		
Application	Impacts	Cost
Improve HVAC System	Energy Reduction, Emissions Reduction	Varies
Replace Lighting Fixtures with Energy Efficient ones	Energy Reduction, Emissions Reduction	Varies
Photovoltaics	Energy Reduction, Emissions Reduction	Varies
Sensors	Energy Reduction, Emissions Reduction	Varies
Green Roof	Energy Reduction, Emissions Reduction	Varies
Improve Insulation	Energy Reduction, Emissions Reduction	Varies
Conduct Energy Audits	Energy Reduction, Emissions Reduction	Varies
Vending Misers	Energy Reduction, Emissions Reduction	Varies
Delamping	Energy Reduction, Emissions Reduction	Varies
Energy Star Appliances	Energy Reduction, Emissions Reduction	Varies
Solar Hot Water Heater	Energy Reduction, Emissions Reduction	Varies
Improve Window Efficiency	Energy Reduction, Emissions Reduction	Varies
Improve Infiltration	Energy Reduction, Emissions Reduction	Varies
Improve Insulation	Energy Reduction, Emissions Reduction	Varies
Add Shading Devices	Energy Reduction, Emissions Reduction	Varies

Application

Changes in sustainability education are necessary in the policy, curriculum and pedagogy of institutional structures. Sustainability education exists in all stages of education.

1.1 Application Combination

As mentioned in the Levels of Sustainability section, most students in High School graduate with a Level 1 understanding of sustainability which is awareness. An illustration of the existing sustainability levels in High Schools today is shown below.

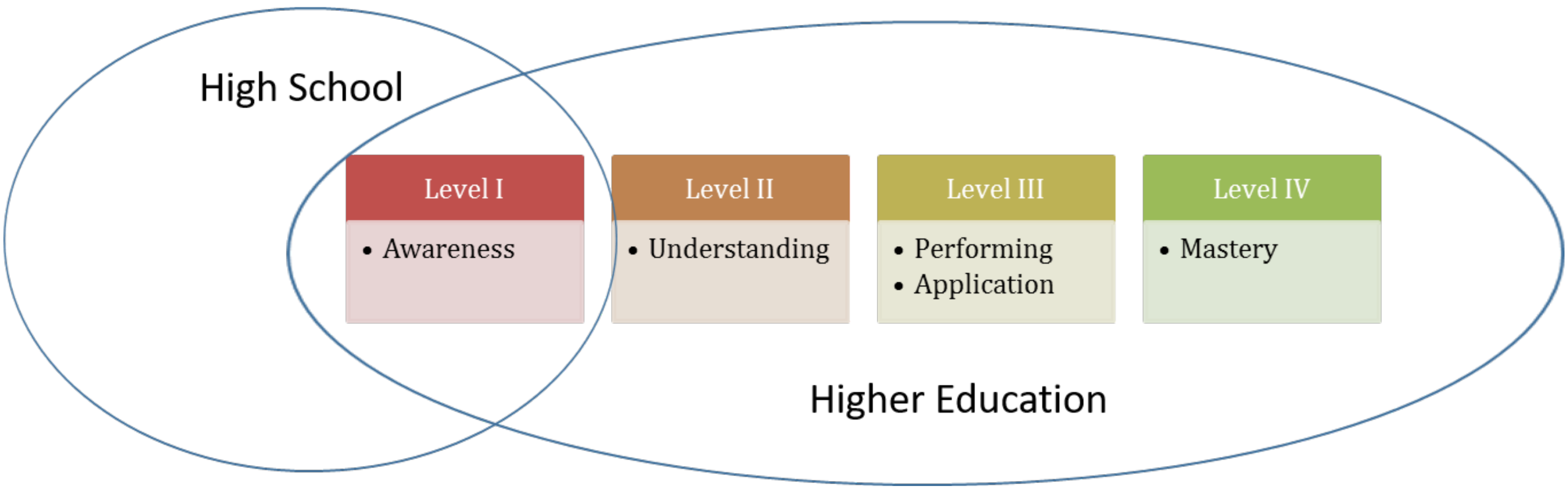


Figure 14 Existing Levels of Sustainability Education incorporated in Educational Institutions

Through research, it was concluded that awareness does not correlate with sustainability action, therefore, this study suggests a different level system implemented in High School. Based on the levels of sustainability, a method of describing the transition of levels implementing in High School is shown below.

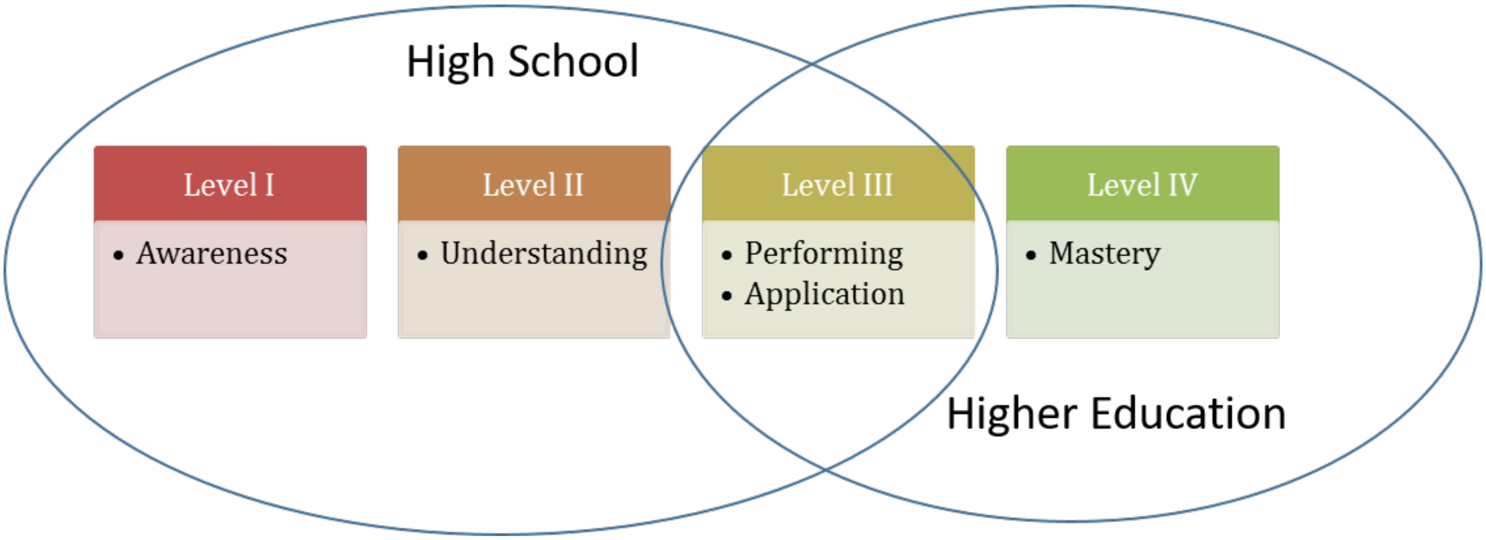


Figure 15 Proposed Levels of Sustainability Education implemented in High Schools

This image demonstrates that with the application of behavior-based strategies in a High School, students will be able to learn three levels of sustainability as opposed to one and will better prepare them for Higher Education, future careers, and society.

1.2 Application Delivery

Since there is a huge gap between theory and practice in High School, the implementation of these behavior-based strategies will induce sustainability actions in students and lead them to accomplish the three Levels of Sustainability education before they graduate. A sustainability committee between students, faculty, and staff must be assembled to help identify and direct needed efforts through visionary campus leaders. This approach will create an interdisciplinary team whom will enhance sustainability education through operations, staff, faculty, students, and the community. This approach enhances and educational experience inside and outside of a classroom where students learn about sustainability through behavior and practice.

Merging Arizona Curriculum with Sustainability Levels of Education

	9th Grade	10th grade	11th grade	12th grade
Water Usage	Describe factors that impact current and future water quantity and quality including surface, ground, and local water issues.	Identify how water is cycled within the Earth system	Analyze methods of reclamation and conservation of water.	Design models (conceptual or physical) of the following to represent "real world" scenarios: • water cycle
		Predict how a change in rainfall can affect the number and diversity of species in an ecosystem.		
Energy Consumption	Explain the energy transfers within chemical reactions using the law of conservation of energy.	Describe the following ways in which energy is stored in a system: • mechanical • electrical • chemical • nuclear	Evaluate the effectiveness of energy conservation practices and preservation techniques	Analyze the use of renewable and nonrenewable resources in Arizona
	Describe the characteristics, location, and motions of the various kinds of the sun	Explain the mechanisms of heat transfer (convection, conduction, radiation) among the atmosphere, land masses, and oceans.		
Waste Output	Describe how human curiosity and needs have influenced science, impacting the quality of life worldwide.	Assess how human activities (e.g., clear cutting, water management, tree thinning) can affect the potential for hazards.	Investigate the effects of urban developmenton climate change over various periods of time.	Evaluate methods used to manage natural resources
CO_2 Emissions	Describe the environmental effects of the following natural and/or human-caused hazards	Evaluate the effect CO_2 emissions affect the quality of the environment	Predict the effect of a change in CO_2 emissions on a human population.	Analyze the costs, benefits, and risks of various ways of dealing with Co2 Emissions

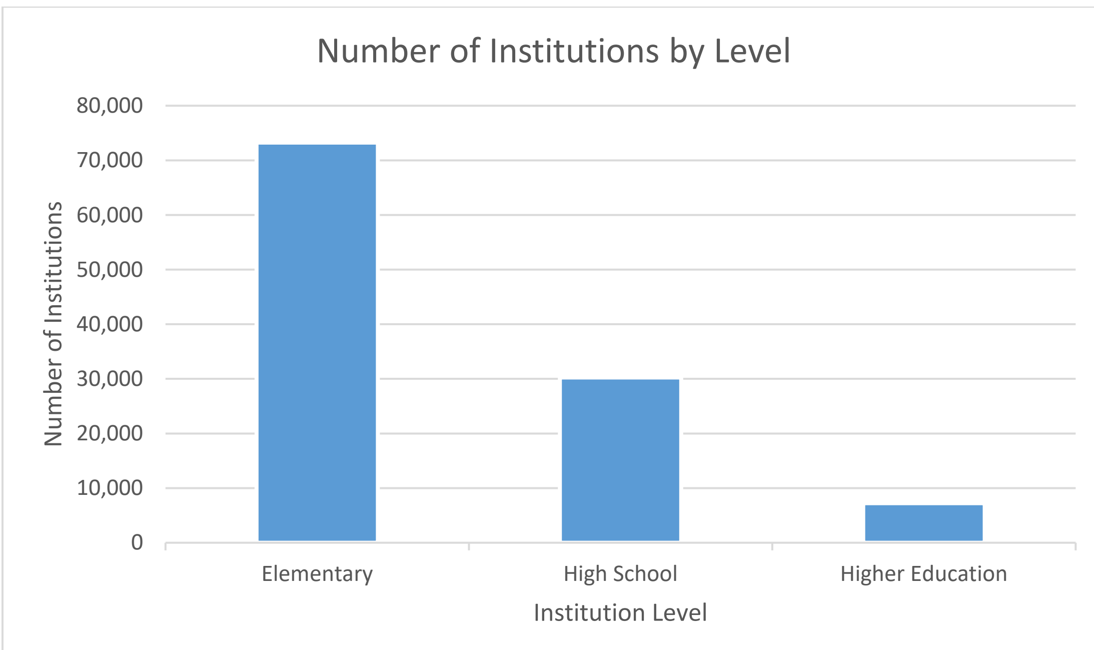
Targeted Audience

Even though this Toolkit is targeted to High Schools, it can be shaped and reformatted to be implemented in Middle Schools, Elementary Schools and potentially any company or organization that wants to advocate sustainability through behavior change and practice. This toolkit has the potential to target educational institutions in cities, states, and countries.

Targeted Audience in United States

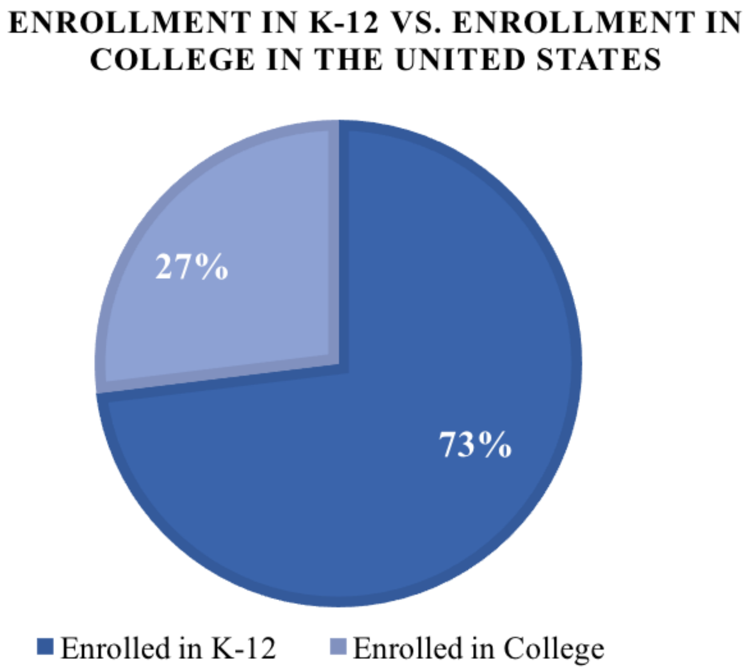
The United States Census Bureau (2015) states that the Unites States population is about 324,696,000. The United States is made up of thousands of educational institutions. They are either elementary, high school, and higher education institutions seen in the table below.

Table 52 Number of Institutions by Level. Source: Adapted from U.S. Department of Education, National Center for Education Statistics. (2016). Digest of Education Statistics, 2015 (NCES 2016-014), Chapter 2.



There are 73,239 Elementary institutions compared to 30,258 High Schools and 7,236 Higher Education institutions existing in the US. There are also 13,506 school district in the US. Out of these institutions, 55.6 million are enrolled in K-12 compared to 20.5 million enrolled in Higher Education as seen in Table 53.

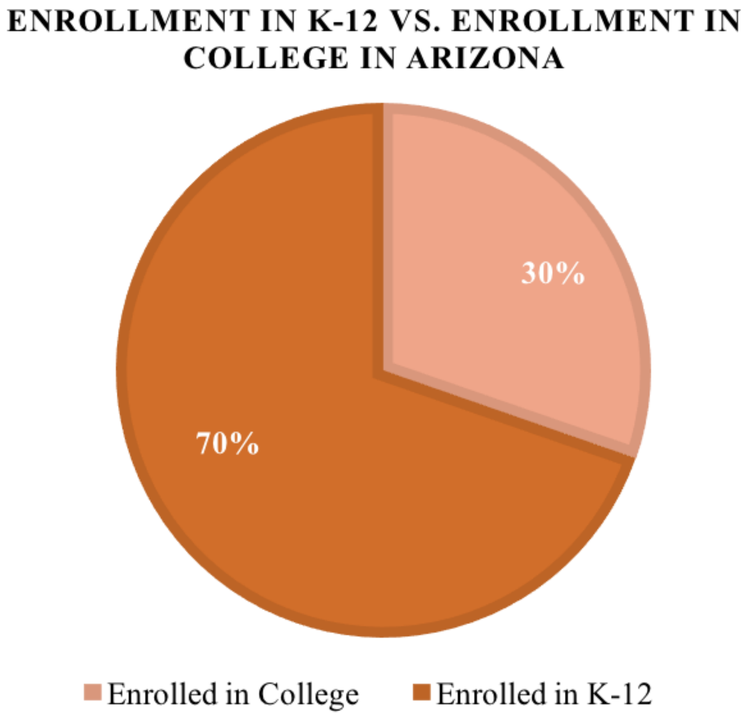
Table 53 Table of Enrollments in K-12 vs. College in the U.S. Source: Adapted from US Census



Targeted Audience in Arizona

The United States Census Bureau (2015) states that Arizona's population is about 6,828,065. There are currently 1,044,785 students enrolled in K-12 institutions compared to 454,759 enrolled in Higher Education institutions illustrated in Table 54.

Table 54 Table of Enrollment in K-12 vs. in College in Arizona. Source: Adapted from US Census



There are also a total of 188 school districts in Arizona.

Dropout Rate

Although the United States high school dropout rate has decreased by 3% from 1990 to 2010 (12.1% to 7.4%) according to the U.S. Department of Education, there is still a lot of improvement that should be made because no one at a young age should be deprived of their education. The following image depicts graduation rates in the US with Arizona having a 74.7 graduation rate.

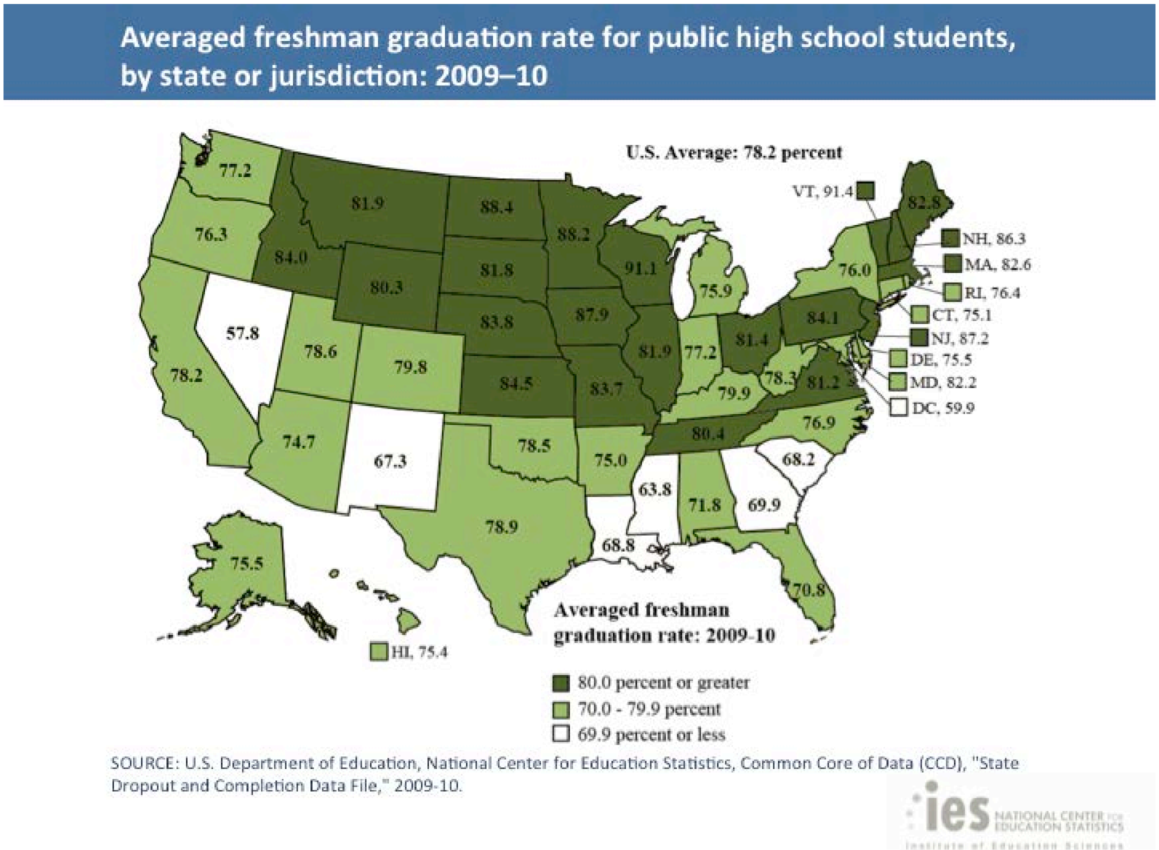


Figure 16. Freshman graduation rate for public high school students. Source: US Department of Education

Compared to developed countries across the world, the US had one of the highest education rated globally. Today, it ranks 22nd out of 27 developed countries worldwide (Banchero, 2016). Out of the total students enrolled in High School in the United States, 1.2 million of them drop out yearly (Miller, 2015). To put this number into context, that is a student dropping out every 26 seconds or 7,000 students a day. These numbers are created nationally, but when thinking of specific schools in the US, 2,000 of them graduate less than 60% of their students which account to 50% of the total students who dropout yearly (Sparks, 2016). These numbers don’t take into consideration the percentage of students who take longer than four years to graduate which is around 25% of incoming High School Freshman (Silver, 2016). The dropout rate in High Schools tied directly to the quality of education given to students. If a better quality of education is given by correlating real-world issues into a systematic holistic approach, more students will graduate and continue their higher education. Those who only graduate High School will be prepared to commit to sustainability actions in their desired careers.

Developers

The developers of the toolkit will be based on a collaboration of educational leaders. These leaders include Higher Education professionals in the state and district level, university professors, and science teachers. There are a total of 7.2 million teachers in the United States and more that 4 million are postsecondary teachers (US Census, 2011).

1.3 Application Conclusion

The application of these strategies will reduce the cost of utility bills and increase education inside and outside of the classroom. The goal of this research is to lean towards educating the user as opposed to wasting more money by adding technical strategies first as opposed to reducing through behavior then applying technical strategies. This concept is illustrated in the following image.

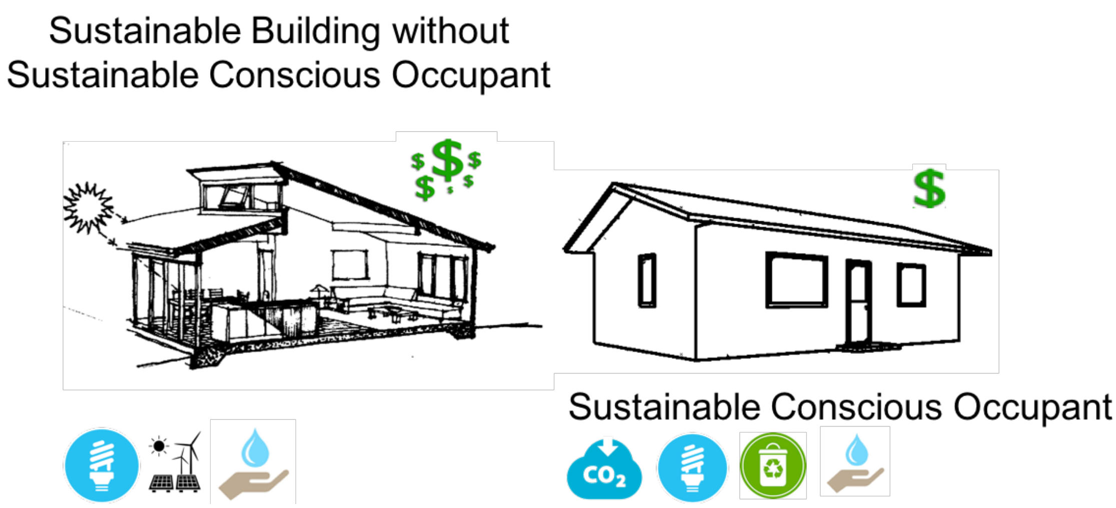


Figure 17 Comparison between sustainable building versus regular building with sustainable conscious occupant

This concept can be applied to institutions globally where students, faculty, staff, and society can be positively affected through the application of behavior-based strategies and recycling the utility saving towards the application of either educational benefits such as increasing faculty wages and purchasing material or implementing technical-strategies in the building to further increase its efficiency.

Validation

Based on the gap between theory and practice in High School, the implementation of behavior-based strategies in a High School will results in reductions in the four factors introduced above which were water usage, energy consumption, waste output, and CO_2 emissions. The application of these methods in High Schools will be validated and measured through the school's utility bills through a level III energy audit.

A level III Energy Audit examines the potential for energy efficient improvements during the detailed analysis of the building's energy consumption with the help of an energy simulation system. Today's monitoring technologies and innovations in data logging computing technologies and sensing have improved monitoring the energy performance of the built environment (Sharmin, et al, 2014). The preparation of the audit includes the review of the building's drawings such as- architectural, mechanical, and electrical. It also includes the analysis of a year's worth of energy bills and an interview with the homeowner to understand operational practices and concerns. An energy audit is essential towards determining the building's energy saving measures.

The amount of money saved can be used to benefit the school in so many ways. Cost savings can be implemented in retrofitting a school by improving its efficiency through technical strategies mentioned above. This money can also go towards increasing faculty wages to improve sustainability education. A third way this money can be allocated is to increase sustainability education efforts in research, field-trips, and materials. The energy savings and sustainable savings in terms of carbon footprint, water, resources, and energy reductions by applying sustainability education early will be substantial.

Results

The combination of behavioral-change strategies with technical strategies in an institution has potential for great reductions in the four factors which are water usage, waste output, CO_2 emissions, and energy consumption. Survey study demonstrated that even though most students are aware about sustainability, the students whom perform sustainability actions have acquired this personal lifestyle either through higher education or other venues. These findings infer that even though most students are aware of sustainability, it does not correlate with sustainability actions. Therefore, a sustainability toolkit based on behavior-change strategies was created to reduce water usage, waste output, CO_2 emission, and energy consumption. These strategies were organized by effort and impact. After behavior-based strategies are implemented, utility bill savings will recycle into the implementation of technical-based strategies organized by cost and impact.

Conclusion

The future of life and social world on Earth is in jeopardy since poverty, climate change, and CO2 Emissions is occurring worldwide. Simultaneously, there is a worldwide move net towards sustainability. The efforts of sustainability in Higher Education have been clear in most recent years, although, there is still much resistance to change, transform and reimagine society and education for sustainability. Sustainability education must respond and act on this challenge subsequently to respect all forms of life and future generations. Improving sustainability education will retrospectively improve sustainable behavior through creating a conscience community who make sustainable decisions. Sustainability education must respond and act on this challenge subsequently to respect all forms of life and future generations.

Based on the substantial cap between theory and practice of sustainability, educational institutions must lead in sustainability to mold the future into sustainability conscious critical thinkers. Since sustainability education is a priority, educational institutions must address the issue and implement it in its curriculum through a holistic approach which integrates sustainability earlier on in education in order to grasp further understanding once they real higher education of their desired career in society. Although sustainability education exists in all levels, it is more prominent in Higher Education as opposed to Elementary, Middle, and High Schools. Therefore, less students attain the necessary deep understanding of sustainability needed to instill in their career and society since behavior and habits are achieved through repetitive actions that were not instilled earlier in people's educations.

After conducting research through a survey study, three different variables were studied: 1) whether students in high school and higher education knew about sustainability 2) whether students' lifestyle consisted of pro-environmental actions, 3) and whether they learned to perform these actions in high school or higher education. Study found that most students know what sustain

ability is. However, most students engage in pro-environmental actions in higher education because they started learning about them in higher education. Therefore, although most high school students know about sustainability, they aren't engaging in pro-environmental actions. A sustainability toolkit was created based on behavioral change strategies to reduce water usage, CO_2 emissions, energy consumption, and waste output in High Schools. The mission of the sustainability toolkit is to create a pedagogy to assist institutions and communities to develop the skills and knowledge to work sustainably.

Discussion

These four factors of sustainability that are being evaluated in this study through behavioral and technical strategies are limited. This study can be extended to different variables of behavior change such as adding social justice to the four factors of sustainability included in this study. Such efforts could include creating campaigns to limit sweatshop athletic apparel sold by the institution or company. This study is also limited in the fact that it doesn't tie behavioral strategies in a global setting to culture and effects of economic social negative aspects that relate to mass production. Therefore, these limitations can positively improve this toolkit through future research.

World green building trends have doubled every three years with 70 countries reporting 60% of their projects will be green by 2018 (Dodge Research and Analytics, 2016). UNESCO has calculated that in the next 30 years more people will receive formal education than in all of human history. With that being said, sustainability education is critical in today's society to generate sustainability conscience future leaders.

References

1. Athienitis, A., & O'Brien, W. (2015). Modeling, design, and optimization of net-zero energy buildings. Berlin, Germany: Ernst & Sohn.
2. Banchero, Stephanie. "High-School Graduation Rate Inches Up." The Wall Street Journal. Accessed February 27, 2016, http://online.wsj.com/news/articles/SB10001424127887323301104578256142504828724.
3. Barnes, E., & Parrish, K. (2016). Small buildings, big impacts: The role of small commercial building energy efficiency case studies in 2030 districts. Sustainable Cities and Society, 27, 210-221. doi:10.1016/j.scs.2016.05.015.
4. Becchio, C., Corgnati, S.P., Delmastro, C. (2016). The role of nearly-zero energy buildings in the transition towards Post-Carbon Cities. Sustainable Cities and Society, 27, 324-337. doi.org:10.1016/j.scs.2016.08.005.
5. Beveridge, D., McKenzie, M., Vaughter, P., & Wright, T. (2015). Sustainability in canadian post-secondary institutions. International Journal of Sustainability in Higher Education, 16(5), 611-638. doi:10.1108/IJSHE-03-2014-0048
6. Brown, Emma. "The nation's high school dropout rate has fallen, study says". The Washington Post. November 10, 2015. Retrieved April 11, 2016, from <https://www.washingtonpost.com/local/education/the-nations-high-school-dropout-rate- has-fallen-study-says/2015/11/09/3c8db2cc-86fd-11e5-be39-0034bb576eee_story.html>.
7. Brundtland, G.H., Khalid, M., Agnelli, S., Al-Athol, S.A. and Chidzero, B. (1987). Report of the world commission on environment and development: Out common future, UN General Assembly, available at: www.un-documents.net/our-common-future.pdf (Accessed December 9 2016).
8. Caliyurt, K. T., Yüksel, Ü., & ProQuest (Firm). (2017). Sustainability and management: An international perspective. Abingdon, Oxon;New York, NY;: Routledge, an imprint of the Taylor & Francis Group.
9. Cato, Linda. School Planning and Management. "Everyone a Changemaker: Education for the 21st century". Retrieved March 1, 2016, from <https://webspm.com/articles/2016/01/01/21st-century-education.aspx>.
10. Colby L. Sandra and Ortman M. Jennifer. "Projections of the Size and Composition of the U.S. Population: 2014 to 2060. Retrieved December 1, 2016, from <https://www.census.gov/content/dam/Census/library/publications/2015/demo/p25-1143.pdf>.
11. Crosby, Kate. (2013). "Powering Down: A toolkit for behavior-based energy conservation in K-12 schools". Retrieved March 19, 2017.
12. Dearden, P. and Michell, B. (1998), Environmental Change and Challenge: A Canadian Perspective, Oxford University Press, Toronto.

13. Diekmann, A., & Preisendoerfer, P. (1992). Persoenliches Umweltverhalten: die Diskrepanz zwischen Anspruch und Wirklichkeit. Koelner Zeitschrift fuer Soziologie und Sozialpsychologie, 44, 226–251.
14. Disinger, J. 1983. Environmental education's definitional problem. ERIC/SMEAC information Bulletin 2. Columbus, ERIC/SMEAC. In Environmental education for the 21st century: international and interdisciplinary perspective, ed. P. J. Thompson, 3-11. New York: Peter Lang.
15. Dodge Research and Analytics (2016). World Green Building Trends 2016 SmartMarket Report.
16. Dyer, A., Selby, D. and Chalkley, B. (2006) 'A Centre for Excellence in Education for Sustainable Development, vol 3, no 1, pp75-85.
17. Epa (2014).
18. Frederiks, E. R., Stenner, K., & Hobman, E. V. (2015). Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. Renewable and Sustainable Energy Reviews, 41, 1385-1394. doi:10.1016/j.rser.2014.09.026.
19. Georgia Department of Education. 2015. Retrieved December 15, 2015, from https://www.georgiastandards.org/resources/Pages/Environmental_Education.aspx.
20. Habit. (2017). In Encyclopædia Britannica. Retrieved from http://academic.eb.com/levels/collegiate/article/habit/38702
21. Jones, P., Selby, D., 1945, & Sterling, S. R. (2010). Sustainability education: Perspectives and practice across higher education. Washington, DC;London;: Earthscan.
22. Knobloch, F., & Mercure, J. F. (2016). The behavioural aspect of green technology investments: A general positive model in the context of heterogeneous agents. Environmental Innovation and Societal Transitions, 21, 39–55.
23. Lenzen, M., & Cummins R. A. (2011). Lifestyles and Well-Being Versus The Environment. Journal of Industrial Ecology, 15(5), 650–652.
24. Maclay, W., 1948. (2014). The new net zero: Leading-edge design and construction of homes and buildings for a renewable energy future. White River Junction, Vermont: Chelsea Green Publishing.
25. Mader, C. (2011). Launching the COPERNICUS alliance: European network on higher education for sustainable development. Journal of Education for Sustainable Development, 5(1), 7-8. doi:10.1177/097340821000500104
26. Mariësse A E van Sluisveld, Martínez, S. H., Daioglou, V., & Detlef P van Vuuren. (2016). Exploring the implications of lifestyle change in 2 °C mitigation scenarios using the IMAGE integrated assessment model. Technological Forecasting and Social Change, 102, 309-319. doi:10.1016/j.techfore.2015.08.013
27. Meyer, A. (2015). Does education increase pro-environmental behavior? evidence from europe. Ecological Economics, 116, 108-121. doi:10.1016/j.ecolecon.2015.04.018
28. Miller, Tony. "Partnering for Education Reform." U.S. Department of Education. Accessed February 18, 2016.
29. Moglia, M., & Cook, S., & McGregor, J. (2017). A review of Agent-Based Modelling of technology diffusion with special referent to residential energy efficiency. Sustainable Cities and Society, 31, 173-182. Doi: 10.1016/j.scs.2017.03.006

30. Digest of Education Statistics (2001). National Center for Education Statistics. Retrieved from: https://nces.ed.gov/pubs2002/2002130.pdf.
31. Princeton Review (2016), "The Princeton Review gives 703 colleges green ratings in new 2011 editions of its annual college guides and website profiles of schools", available at: www. princetonreview.com/green/press-release.aspx (accessed January 20, 2016).
32. Raleigh. (2008). aashe 2008. Journal of Education for Sustainable Development, 2(2), 99-100. doi:10.1177/097340820800200203.
33. Sammalisto, K., Sundström, A., von Haartman, R., Holm, T., & Yao, Z. (2016). Learning about Sustainability—What Influences Students' Self-Perceived Sustainability Actions after Undergraduate Education?. *Sustainability*, *8*(6), 510.
34. Satterthwaite, D. (2011). How urban societies can adapt to resource shortage and climate change. Philosophical Transactions of the Royal Society A, 369, 1762–1783.
35. Sharmin, T., Gul, M., Li, X., Ganev, V., Nikolaidis, I. (2014). Monitoring building energy consumption, thermal performance, and indoor air quality in a cold climate region. Sustainable Cities and Society, 13, 57-68. Doi:10.1016/j.scs.2014.04.009.
36. Silver, David, Marisa Saunders, and Estela Zarate. "What Factors Predict High School Graduation in the Los Angeles Unified School District." Attendance Counts. Accessed February 18, 2016.
37. Sorrell, S., Mallett, A., & Nye, S. (2011). Barriers to industrial energy efficiency: A literature review. Working Paper 10/2011. United Nations Industrial Development Organization.
38. Sparks, Sarah D. "Study Points to Fewer 'Dropout Factory' Schools." Education Week. Accessed February 8, 2016.
39. Suárez-Varela, M., Guardiola, J., & González-Gómez, F. (2016). Do pro-environmental behaviors and awareness contribute to improve subjective well-being? Applied Research in Quality of Life, 11(2), 429-444. doi:10.1007/s11482-014-9372-9
40. The association of university leaders for a sustainable future (ULSF) announces its new web site. (2001). International Journal of Sustainability in Higher Education, 2(4) doi:10.1108/ijshe.2001.24902dab.001
41. UNCED (1992) Agenda 21: Programme of Action for Sustainable Development, UN Department of Public Information, New York NY.
42. UNESCO (1972), The Stockholm Declaration, UNESCO, Stockholm. UNESCO (1990), The Talloires Declaration, UNESCO, Gland.
43. UNESCO (1993), The Swansea Declaration, UNESCO, Gland. UNESCO (1997), Thessaloniki Declaration, UNESCO, Gland.
44. UNESCO-UNEP (1977), Tblisi Declaration, UNESCO-UNEP Press, Moscow. University Leaders for a Sustainable Future (1990), The Talloires Declaration, ULSF, Washington, DC.
45. UNESCO (2004) *United Nations Decade of Education for Sustainable Development (2005-2014): Draft International Scheme*, UNESCO, Paris.
46. U.S. and World Population Clock. Retrieved December 1, 2016, from <http://www.census.gov/popclock/>.
47. U.S. Department of Education. "Fast Facts: Dropout Rates." Institute of Education Sciences. Accessed February 3, 2016, https://nces.ed.gov/fastfacts/display.asp?id=16.
48. U.S. Bureau of Labor Statistics as cited in the Statistical Abstract of the United

States: 2011, Table 615 https://www.census.gov/compendia/statab/.
49. U.S. Census Bureau. Monthly Retail Trade and Food Services. 2010. Retrieved from <https://www.census.gov/retail/index.html>.
50. US EPA, Energy Efficiency Programs in K-12 Schools (2016).
51. Vermont Energy VEEP Educational Program. Web. 25 Jan. 2016. <http://veep.org/>.
52. Weidema, B.P., Thrane, M., Christensen, P., Schmidt, J. and Lokke, S. (2008). Carbon footprint: A catalyst for life cycle assessment? *Journal of Industrial Ecology*, 12(1), 3-6.
53. Wright, Tarah S. A. "Definitions and Frameworks for Environmental Sustainability in Higher Education." Higher Education Policy, vol. 15, no. 2, 2002, pp. 105-120, doi:10.1016/S0952-8733(02)00002-8.