

JD

Project Number: JDK FOOT

AN ENVIRONMENTAL FOOTPRINT QUIZ FOR WPI STUDENTS

AN INTERACTIVE QUALIFYING PROJECT REPORT
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BY

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1 ABSTRACT

This IQP investigates the applicability of environmental footprint quizzes to the WPI student body. The goal is to allow students to accurately gauge their resource use and encourage them to reduce consumption. To accomplish this, I analyzed similar quizzes, designed a WPI-specific quiz, and ran a beta test on the effectiveness of this quiz for students. The final edition of the quiz is available on users.wpi.edu/~cvandyke/quiz.

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5 PROJECT OVERVIEW

5A PURPOSE

"If knowledge can create problems, it is not through ignorance that we can solve them."

Isaac Asimov (Moncur)

Earth cannot support the current human population at its current standard of living. Forests are razed for lumber, the ground sucked dry of oil, and poison dumped in the ocean. To use a common metaphor, we are living off Earth's capital, when we should be living off the interest.

There are two solutions to solve this problem: either we can drastically reduce the human population on the planet, or the people living here must make significant reductions in the amount of resources they consume and the amount of waste they generate. Some combination of the two is also a possibility.

Ignoring the possibility of reducing the population, a more optimistic approach reduces the impact of each person on the environment by conserving energy and reducing waste. The ideal for this model is for a population to use each year only the resources in its own territory that can be replenished in a year. This goal is referred to as sustainability, or being environmentally neutral.

While WPI has already made a move to become environmentally neutral with their Sustainability Council, rules enforced by the campus have limited effect on the behavior of individual students, and less once the students graduate. Since college and the period shortly after graduation are a time of crucial decisions with long-lasting consequences, educating students on the environmental impact of their choices is of particular interest.

College students typically choose their first car, which may last anywhere from a year—for the unlucky or poor drivers—to ten years. The emissions of that car will likely be less important to the student than the color, style, price, or horsepower.

They also choose living space. Some live at home, some in a dorm, and some in an apartment. A small minority have their own houses. The students must heat, clean, and light these places, regardless of the location or who pays the bills. This impact may go unnoticed by the students.

In or shortly out of college, students choose their careers. If that job is far from home, the energy used for travel will leave a mark on the environment. If that job is in a field that is detrimental to the environment, such as oil drilling or chemical manufacturing, they should consider themselves responsible. Some individual companies may be particularly cavalier with natural resources, although more research is necessary to separate companies with poor public relations from ones that are truly unsustainable.

Some students will consider the environmental cost of a choice; some students choose for other reasons; and some students take a choice for granted. This project has the potential to help all three. For the environmentally-aware student, the quiz will track progress. For students trying to live completely sustainably, checking with the quiz periodically will determine how well they reach their goal. In addition, students can predict the effect of future choices by answering as if they had already chosen. By comparing these results with their own, students can determine whether the choice is reasonable without needing to do research.

The quiz reminds oblivious students of the environmental consequences of their actions. It allows those students to see the consequences of their choices, with advice on how to improve. The choice belongs to the students on whether to take that advice, but if the quiz is entertaining, clear, and strong about those points, the students may take the advice.

Finally, some students may honestly not believe another choice exists. For instance, line-drying laundry would be a foreign concept for a student whose family never uses anything but the dryer. A student whose family's diet is strictly meat and potatoes may be startled with the variety of good vegetarian food. If the quiz can persuade those students that more environmentally sound alternatives to their lifestyle exist, the student may be willing to try it.

5B PROJECT GOALS

This project involves the development of an environmental footprint calculator specifically designed for WPI students, based on the fact that students typically have limited control over their surroundings and limited access to feedback on their personal energy use.

While there are many tools designed to analyze environmental impact, there are none easily available that are suitable for a college student. For this project, I intend to

- develop a systematic method of evaluating the tools available
- use the rubric to determine the best tools
- adapt the tools for use with college students
- use the data from the tool to display customized advice on important college choices: major, car, housing, and career path
- evaluate the tool using feedback from likely users (WPI students)

6 BACKGROUND

6A ENVIRONMENTAL FOOTPRINTS

As stated above, a key tenet of sustainability is that a community does not exceed its physical territory. However, not all land is created equal. For example, dense forest land is rich in lumber, but extremely poor in food. Typically, a population living in this terrain would sell the excess lumber in exchange for food. In effect, it trades an acre of forest land for some amount of farmland.

The purpose of an environmental footprint is to quantify this divorce between a population and its physical location. A person's environmental footprint measures how many hypothetical acres would be needed to support you sustainably. The key assumptions are:

- Each acre of land has the same kind of resources that the whole planet does. This is not true – if you use all of the resources in an acre of farmland, you have more environmental impact than the person using the resources in an acre of tundra – but allowing a “typical acre” simplifies representation.
- Every resource renews itself after some period of time.
- Farms produce at the levels they do sustainably. This may not necessarily be true, but it simplifies the calculations.
- Other species are not valued in their own right, they are considered resources. (Mathis Wackernagel)

The first report on environmental footprints was published in 1992 by William Rees. (Rees 121-130) It was designed to be a set of calculations to make the concept of the appropriated carrying capacity of the planet more accessible to non-scientists.

This concept proved to be popular. More publications followed, expanding the concept to individual resource use. Developers used the formulas in quizzes so individuals could gauge their own impact. Currently, there are more than 50 of these tools according to Google.

The benefit of these quizzes is their ease of use. None of the quizzes I studied took more than half an hour, and the simple question-and-answer structure kept the quiz clear.

However, the structure also works against footprint quizzes. The quiz format is easy to complete, but it cannot adapt to every user in the way an interview with an environmental researcher can. To accommodate this weakness, the quizzes I found tended to be designed for a particular demographic, allowing for at least some consideration for different life situations.

The majority of sampled quizzes were designed for homeowners. The users are presumed to have control over all aspects of their lives. Error is introduced by the infinite amount of detail in a person's life – it's impossible to account for every impact a person has on the environment. However, there are standard formulas for the highest-impact activities.

Housing is one of these. The amount of energy required to build a house varies according to the size of the house, building materials, and location (Brinkley). However, since houses built in the 1960s are still standing today, it seems reasonable to expect today's houses to last at least 50 years. Therefore, the environmental impact of building the house is dwarfed by the energy required to heat all of it.

6B CARBON EMISSIONS

Carbon emissions also measure the impact of human activity on the environment. Burning any organic molecule, such as plant material or fossil fuels, combines with oxygen in the atmosphere to create carbon dioxide (Combustion). Animal life also creates carbon dioxide from respiration.

Either of these activities releases carbon dioxide into the environment. While some carbon dioxide is necessary to support plant life, too much carbon has a detrimental effect.

Sea surface temperatures have increased 1.4°C over the past 500 years. While the temperature today is roughly equivalent to the average temperature over the past 3000 years (see chart below), Robinson associates the temperature increase, starting in the 18th century, with the Industrial Revolution and increase reliance on fossil fuels, especially coal (Arthur B. Robinson)

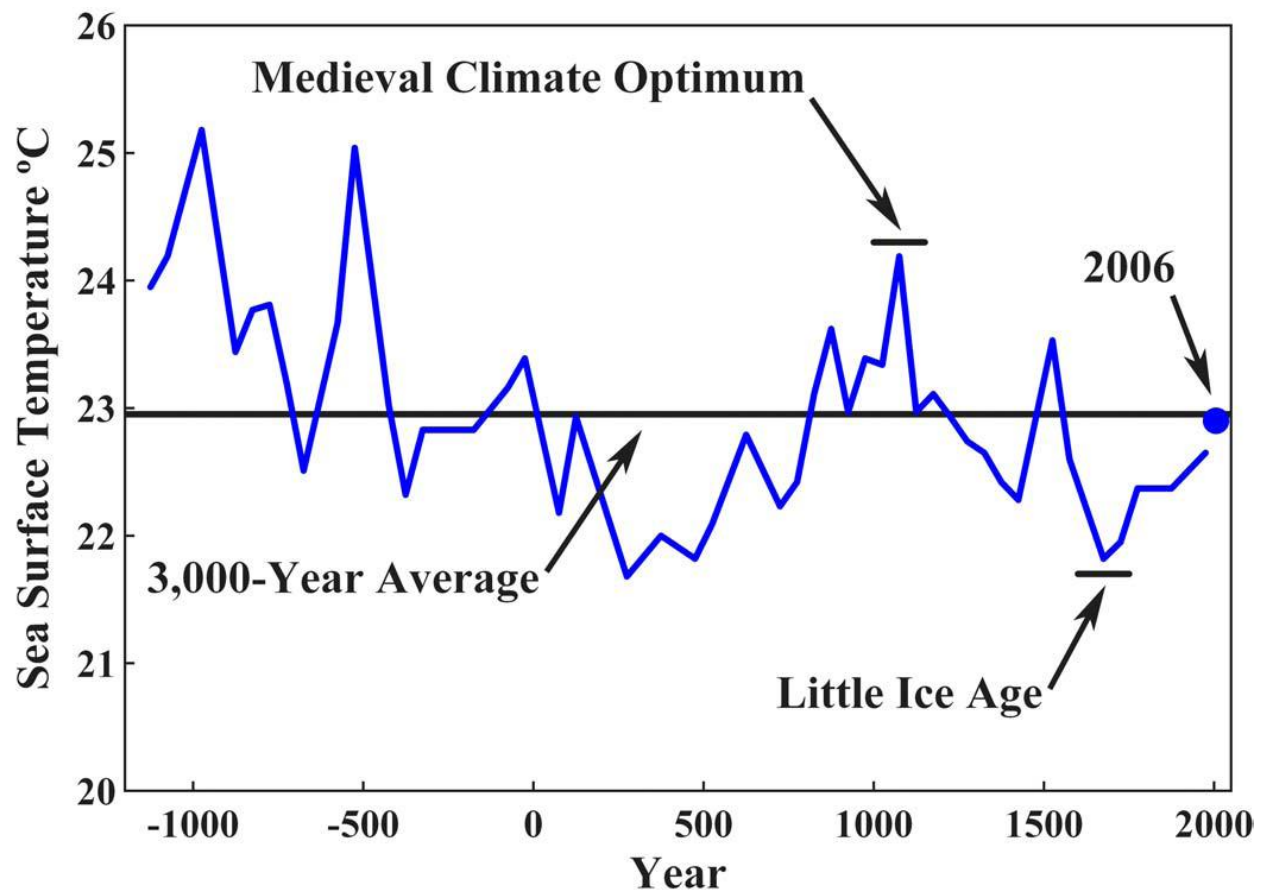


FIGURE 1: TEMPERATURE CHANGES OVER TIME FROM 1000BC

The consequences of this temperature increase are “more powerful and dangerous hurricanes, drought and wildfire, intense rainstorms...deadly heat waves, bad air, allergy, and asthma,

infectious disease and food and waterborne illness outbreaks...ecosystem shifts and species die-off...melting glaciers, early ice thaw [and] sea-level rise” (Council)

Clearly, the amount of carbon dioxide being produced must fall for the planet to remain stable.

7 RESEARCH

7A PREVIOUS ATTEMPTS

Appendix 2 contains tables listing numerical evaluations of the relevant attributes of the quizzes I tested, in addition to comments on how the best features of each quiz could be adapted for use in mine. See that section for more detail on this topic.

To be appropriate for this audience, I hypothesized that an environmental footprint tool would need to:

- be easy to navigate
- be easy to answer
- have a clear scoring system
- visually present the score to the users to evoke a visceral reaction
- be graphically appealing
- give accurate results
- give appropriate advice
- group conceptually similar questions
- leave an emotional impact in the user
- work as intended

I tested other environmental footprint surveys to determine whether any of them were suitable for this particular audience. None were. Most of the surveys I found were aimed towards families, or at least homeowners. A few were geared towards children and preteens, but these would be too condescending to a college student.

Of the surveys I found, I ran through them to determine their best and worst points. Here are the results:

CARBON FOOTPRINT OFFSETTERS: <http://www.offsetco2.ca/calculate.htm>

This calculator was developed by a company selling carbon offsets. As such, it may have been biased. However, when I tried to complete it, the quiz crashed.

GLOBAL FOOTPRINT NETWORK:

http://www.footprintnetwork.org/en/index.php/GFN/page/personal_footprint_calculator/

This calculator was developed by a non-profit environmental awareness group, the same one that made ["The Meatrix"](#). This quiz had the easiest questions to answer, and offered alternate questions if you failed to answer any. However, the advice given by this quiz was poorly tailored. It seems reasonable that advice would consist of the things that are both possible to accomplish and have a high impact for the effort. However, I answered that I had two roommates, and the quiz suggested not living alone. If the user were communicating with a person, this kind of response would not be tolerated.

ECOLOGYFUND.COM: http://www.ecologyfund.com/registry/ecology/res_bestfoot.html

A short tool that is easy to complete, but less satisfying because of its shortness. At the end, it felt more abrupt than simple.

COOL CLIMATE CARBON FOOTPRINT CALCULATOR: <http://coolclimate.berkeley.edu/>

This calculator was developed by a Berkeley student. It had odd variations on the standard housing, food, transportation questions. Instead of asking miles driven and electricity bills, it asked grocery bills and number of fluorescent bulbs. Interesting, but difficult.

PERSONAL EMISSIONS CALCULATOR:

http://www.epa.gov/climatechange/emissions/ind_calculator.html

This is an extremely in-depth footprint calculator put out by the EPA. The formal color scheme works well, the formal tone less so. The WPI tool will automatically be more relevant, but the more personal the better.

WWF ECOLOGICAL FOOTPRINT: <http://www.footprint-wwf.be/footprintpage.aspx?projectId=69&languageId=2>

This calculator was created by the World Wildlife Foundation, and appears to be designed for Europeans over Americans. For instance, hectares are used instead of acres, and one point made in the quiz is how much less “you” (the user) wastes as opposed to Americans, Africans, and Asians. To improve on this tool, mine should use American units and remove the scolding tone.

CONSUMER CONSEQUENCES: <http://sustainability.publicradio.org/consumerconsequences/>

This was created by a non-profit media company as an introduction to ecology for children. While the tone and color scheme were inappropriate for my tool, the idea of giving tailored advice on completion of each question will work well and be easy to implement.

THE NATURE CONSERVANCY: <http://www.nature.org/initiatives/climatechange/calculator/>

This calculator was interesting because it was the first one I came across to consider collective responsibility. You could factor in your family's choices as well (not mandatory). This tool will not implement it, since the calculations are too complex.

AN INCONVENIENT TRUTH: <http://www.climatecrisis.net/takeaction/carboncalculator/>

This was a tie-in to the documentary "An Inconvenient Truth". It shows the flaws of designing a tool with an over-academic tone. The purpose of an environmental footprint is to make resource use accessible to laypeople. Reeling off formulas and variables is a poor way to accomplish that.

TERRAPASS CARBON FOOTPRINT CALCULATOR: <http://www.terrapass.com/carbon-footprint-calculator/>

Interestingly, this one factored in emissions from weddings. Since college students usually get married after graduation, this might be a part of my calculator. It also puts a dollar value on the environmental impact of your life. While this could be considered a useful tool for putting the environmental footprint into perspective, it seems unethical to demand that dollar value to absolve you of your environmental sins. As a result, this quiz has the same emotional impact of a corporate-sponsored charity: although the public benefits something from it, the motivation is clearly not for the public good.

7B NECESSARY FEATURES

I concluded from this research that the single most important attribute is having no errors. Anything else is forgivable, as long as it works. The same goes for the color scheme: Color is good, but too many are worse than none. The multi-page format seems to be a low-effort way to improve the design.

In terms of the results and advice given by the quiz, the “Consumer Consequences” quiz had advice based on each response. This would be difficult to implement, but it would have a greater impact. The results were wildly varied, but this may be a result of differing initial assumptions, such as the availability of ocean resources and animal protection. I plan to use the assumptions given above, and then test the results of my quiz against the results of the other quizzes.

Alternate questions are a simple way to adjust the difficulty level of the quiz. Each question can have a “default/no answer” button, which responds with the average answer for the question. Then there can be a sliding “a lot/a little/none” answer, for those with a grasp of how much they use that don’t have access to numbers. Finally, there should be a numerical response for the most accuracy.

Responding with the number of Earths needed to support your lifestyle for all of humanity has the most emotional impact for me. Since college students typically do not own land, I would guess that the acres needed to support only an individual will have less impact.

7C STUDENT NEEDS

To keep the tool to a manageable length, only facets of college living that have the most environmental impact should be included. I wrote a survey to get a rough gauge of what college students typically use. Because college students do not necessarily have access to utility bills or other raw data, it should be as simple as possible. This is acceptable since the accuracy of this can be low, as long as it remains proportional to the general population. The survey can be found in Appendix 3.

I conducted this study casually. Students were recruited based on convenience; I tended to ask classmates, friends, and roommates. In all, this survey was presented to thirteen students.

The results of this survey indicated that very few students said

- The heat where they lived was anything but “medium”
- They have an oven
- They have a large refrigerator
- They have a large television

This implies that these questions either need a finer gradation of answers, or the question needs another approach. For the heating question, which was the single multiple-choice question, the number of choices for heat was increased from three to four: Hot, Warm, Cool, and Cold. The others were omitted, and replaced with a different approach. The new question asked where the student

lived. Electricity and gas use can be inferred from that building's records, and divided among the residents.

In addition, the laundry question puzzled a number of students, because the typical response was to wash clothes only on returning home during breaks. This question was also omitted from the final survey.

8 ENVIRONMENTAL FOOTPRINT QUIZ

8A IMPLEMENTATION DETAILS

There were a few alternatives to implementing this project. First, it was assumed that this project would be web-based. So, the project would need to be written in some kind of scripting language. The three alternatives I was familiar with going into the project were Scheme, JavaScript, and PHP.

PHP was eliminated quickly. Although it has a simple structure and I have the most experience with it, the WPI server will not host PHP scripts because of their security flaws. At that point, the alternatives were to choose a different language or host it on another server. To keep the project straightforward, other languages were considered.

Scheme is well-supported by the WPI community as a teaching language, but I was afraid it would not be flexible enough for my purposes. I also find functional languages difficult to intuitively troubleshoot.

JavaScript should have the functionality I need for this project. It can change a web page dynamically – that is, while a user is viewing the page. It supports sound and animation. The WPI servers will support JavaScript in the user pages. In addition, both compilers I currently own (Eclipse and Visual Studio) support testing JavaScript code. My experience with this language is less than with PHP or Scheme, but I believe it is most appropriate for the task.

The quiz, as implemented with JavaScript, is one page, to allow the information to be passed across sections with minimal overhead. Each of the sections is hidden and shown based on user input, but the entire quiz is always active. The help comments are also present in the page at all times. They are shown and hidden with the “Help” and “X” buttons. The results page is also present while the

user is completing the quiz, and results are generated dynamically. The practical result of this is a user can check their results even before the quiz is completed.

8B CALCULATIONS

Each response for the quiz is assigned some amount of carbon emissions that choice costs. The results are a simple sum of these costs. Since this quiz does not include all possible choices that have an impact on the environment, this value is skewed low. I accept this value because many of the tests showed multiple earths were required for sustainability, even when underestimating impact. Erring the other way, by overestimating the impact on the planet, would be alarmist if underestimating would have the same result in a milder form.

To see the value assigned each response on the quiz, go to the site and click the 'Help' button. A full breakdown of the research, assumptions, and values behind each response can be found in Appendix 3.

8C BETA TEST

A quiz was developed based on the results of the student requirements survey and my analysis of the previous work. This was given to members of the Psychology Subject Pool to be evaluated. This evaluation matches the one I used to evaluate the previous attempts, with adjustments to make the evaluation easier and faster to complete. Information relating to this study can be found in Appendix 4.

This part of the project was broken down into multiple possible sessions. Members of the PSP who chose to participate chose their time slot at the same time. To reduce the load on the ADP Lab, who hosted this study, only three students were allowed to select any single time slot.

The subjects who chose this study were 62% male and 38% female. Since there are roughly twice as many males as females on campus, this represents a fair gender balance for WPI students. Many refused to respond when asked their age, or misrepresented themselves, but the subjects all seemed to be between 18 and 23, except for two who looked older.

Students typically arrived for their slot a few minutes in advance, and received the consent form at that time with a simple study orientation. After signing the consent form, I gave them a page to record their choices on the quiz and a page to summarize their opinion of it. The subjects then started the quiz. The quiz typically took them between 10 and 15 minutes, with several more minutes following while they completed the evaluation. All left well before the end of their time slot.

The results of the numerical portion of the test were as follows:

Ease of use	Appropriateness	Question clarity	Scoring clarity	Graphic appeal	Emotional appeal
10	10	9	7	9	6
9	8	9	5	7	6
9	8	9	8	9	7
8	8	9	6	7	7
10	9	9	8	5	4
8	8	8	4	7	6
7	7	6	4	7	7
10	10	9	5	7	6
8	7	7	4	7	6
9	9	9	9	7	5
8	10	6	9	5	7
8.727272727	8.545454545	8.181818182	6.272727273	7	6.090909091

TABLE 1: BETA TEST RESULTS

The average of all the given responses was 7.47. I weighted the scores using this value, considering scores above this to be acceptable and lower scores to need improvement. So, the results of this

test imply that ease of use, appropriateness, and question clarity are acceptable. The scoring clarity, graphic appeal, and emotional appeal (which averaged below 7.47) should be improved.

I attempted to clarify the scoring by showing how each question contributed to the footprint. I modified the fonts and the color scheme to improve the graphic appeal. Finally, the phrasing of the first page and the results page was edited in the hopes of stirring more enthusiasm for the topic.

The free response part of the quiz was the least reliable in terms of providing feedback. Many of the comments rephrased or emphasized questions on the numerical portion (e.g. “The results made no sense!!!”)

One user complained of incompatibility with his browser, an older version of Internet Explorer.

After research, I found that browser does not support <div> tags, but updated versions of that browser would.

However, one subject caught a particular flaw caused by navigating using both the tabs at the top of the screen and the “Next Page” prompt. I fixed this error in the final version of the quiz.

8D FINAL QUIZ

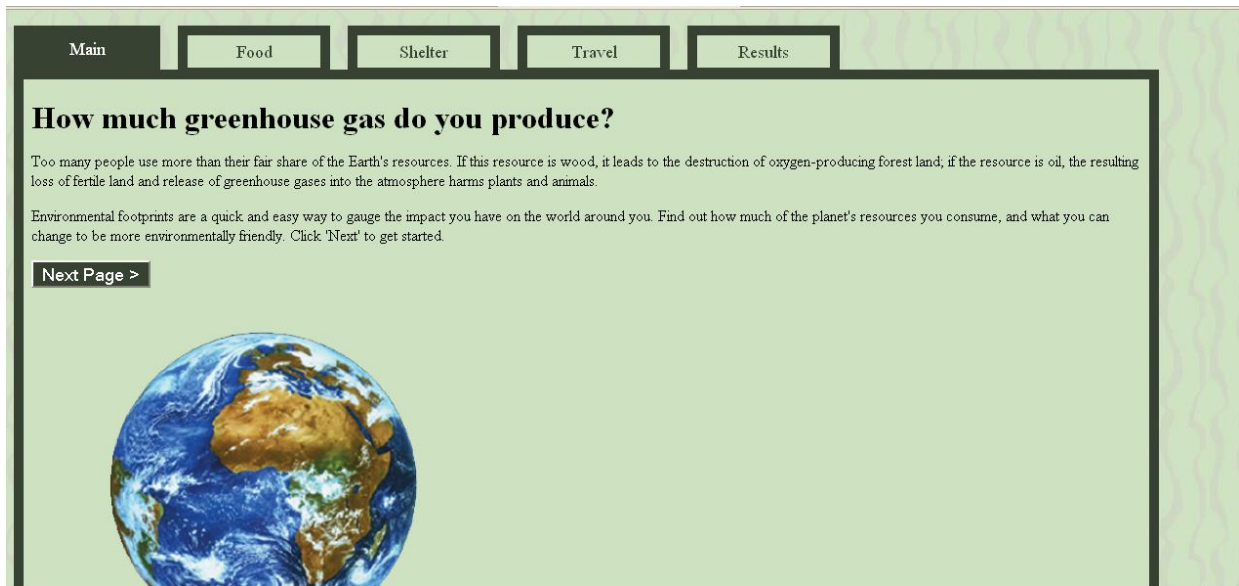


FIGURE 2: MAIN PAGE

The main page presents a justification of the quiz, and reasons to try it.

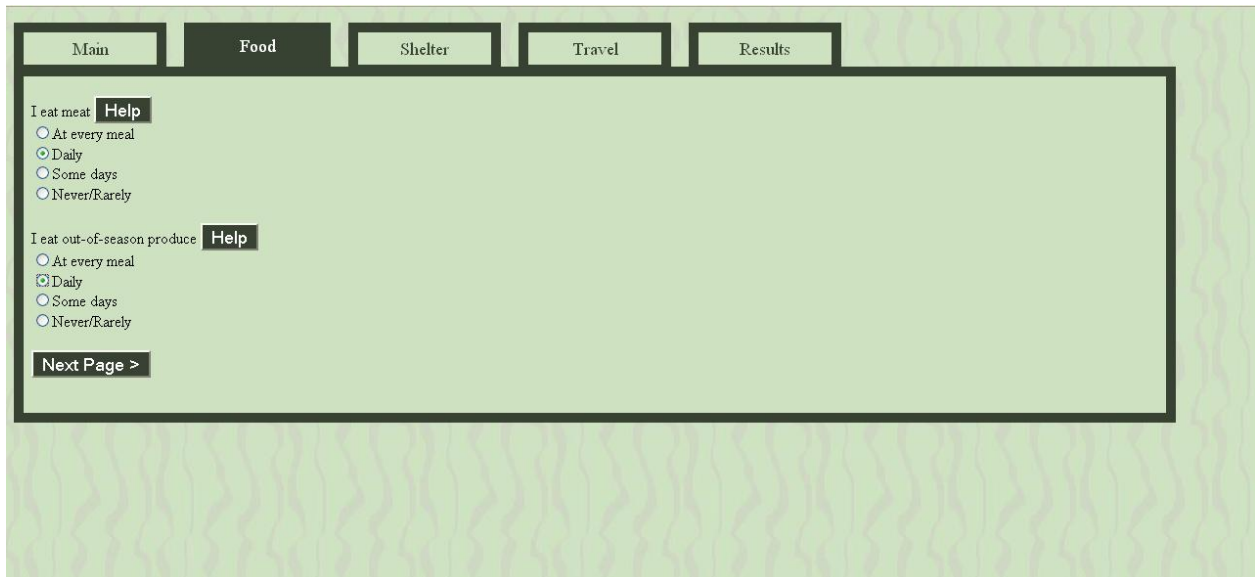


FIGURE 3: FOOD PAGE

This page presents the questions dealing with eating habits. It is broken down into two high-resource areas: meat consumption and exotic produce consumption. While it would be possible to cover all food groups (dairy, local produce, staples), these categories are either too ubiquitous to avoid or environmentally responsible, and therefore sustainable for the purposes of this quiz.

Main Food **Shelter** Travel Results

I live in: **Help**

- ☐ East Hall
- ☐ Morgan Hall
- ☐ Daniels Hall
- ☐ Institute Hall
- ☐ Ellsworth-Fuller Apartments
- ☐ Stoddard Complex
- ☐ Founder's Hall
- ☐ Sanford-Riley Hall
- ☐ Off-campus

The place I live is: **Help**

- ☐ Hot
- ☒ Warm
- ☐ Cool
- ☐ Cold

Next Page >

FIGURE 4: SHELTER PAGE

This page has questions about living arrangements. It does not go into as much detail about the particular appliances or roommate arrangement as the preliminary survey, since for the first the answers were almost unanimous and for the second the calculations were based on the entire building rather than a particular suite.

Main Food Shelter **Travel** Results

Answer one of the following: **Help**

I use gallons of gas per week

I fill my tank every 10 days

I get mpg and drive miles per week

☐ I use an alternative fuel

☐ I don't have a car

How many flights do you take each year? **Help**

short flights

medium flights

long flights

Next Page >

FIGURE 5: TRAVEL PAGE

This page obliquely asks how much fossil fuels a student uses. The environmentally sound options such as riding the bus are assumed to be sustainable, again, so the focus is on the potential unsound options, such as commuting long distances and frequently flying.

In addition, these questions can be answered in a way that implies the environmentally sound options without the need to explicitly ask. For instance, if a student fulfills their travel needs by riding a bus, they would either have no need for a car and check, “I don’t have a car”, or note their low weekly mileage if they did.

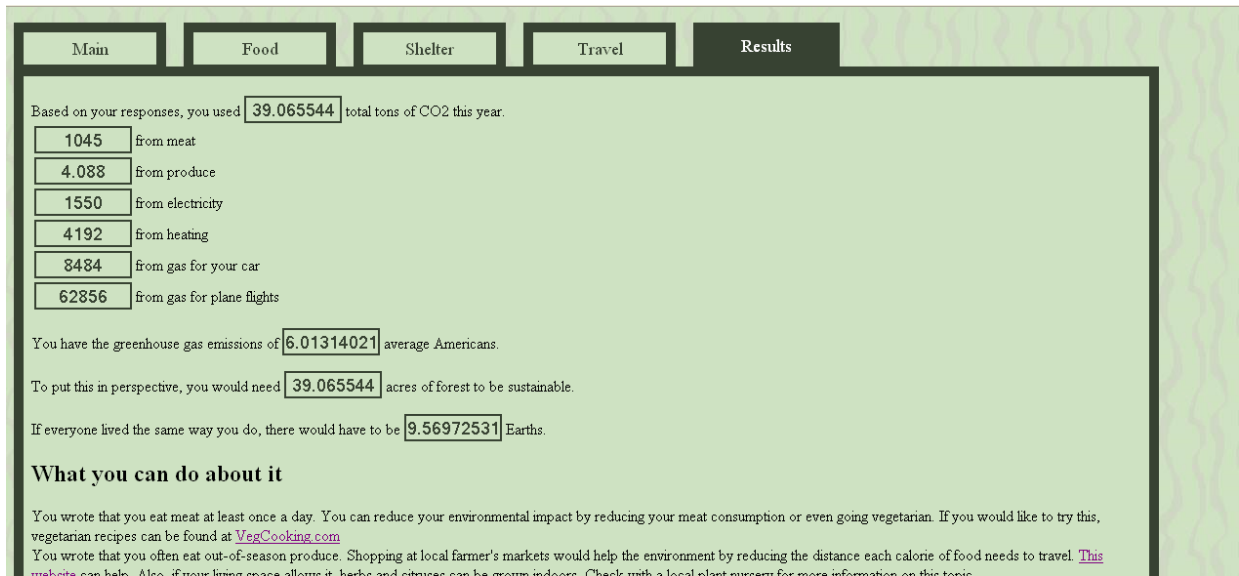


FIGURE 6: RESULT PAGE

Finally, this page presents the results of the quiz. Due to complaints about scoring confusion, the amounts contributing to the total carbon emission are listed with clear parallels to the six preceding questions. To put the carbon emission into perspective, there are several other metrics included on the results page. One is a comparison of your carbon emissions to that of the average American. The environmental footprint is also included in both acre and planet form.

The last page also presents advice on how to improve these numbers. Each unsound response has its own piece of advice, suggesting possible improvements to the user's lifestyle. These pieces of advice are only shown if that particular unsound choice was selected by the user, ensuring that all information is relevant.

9 CONCLUSION

For this project, I set out to make a tool for students to determine what they could do to reduce the impact they have on their environment. For that tool to be a success, it not only had to be factually accurate, but appropriate in tone and focus to the target audience, in this case WPI students.

This project went through a background research stage, finding other footprint quizzes and analyzing their strengths and weaknesses; a need analysis to find which areas of energy use were most important; a first-draft web quiz implemented in JavaScript; a data research stage, finding specific values to use in calculations; and an evaluation stage in the form of a beta test.

This project can be considered a success in that it proved a WPI-specific environmental footprint tool is possible. The beta test confirmed that the quiz is appropriate to the audience, with an appropriateness score of 85%. The quiz is significantly different from existing quizzes, especially with questions relating to living situations and food. Finally, the quiz was highly usable by the testers, implying that the questions were reasonable to ask of a WPI student.

Additional work on this topic can improve on the emotional and aesthetic appeal of the quiz. Narration would improve the emotional appeal, while animation may make the quiz more aesthetically pleasing.

The quiz did not use the concept of collective responsibility, even though student activism would have an effect on the total resources used as a consequence. For instance, a student could run a recycling drive that influences the recycling of several hundred cans that would otherwise have been sent to a landfill. This action would have an effect on resource use as a result of an individual's choices. Calculating this exact difference could be a project for future researchers to implement.

The quiz also left out many opportunities for alternative lines of questions. While the gasoline use question offered multiple options on how to answer, testers complained of not seeing the “Choose one” label and answering them all. Therefore, for future researchers to implement alternative questions, the formatting would need to be updated to alert users.

Finally, while this quiz was designed to be usable and interesting, I did not focus on the long-term impact of this work. Future researchers could test whether this kind of quiz has any measurable impact on users’ choices over time.

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11 APPENDIX 1: RESULTS OF TESTING PREVIOUS ATTEMPTS

11A CARBON FOOTPRINT OFFSETTERS

Category	Score
Ease of use	Could answer some questions easily, but some were difficult. The questions about electricity use were a bit tricky. It asked for specific numbers instead of ranges.
Intended audience	Typical adults (18+). This quiz was geared towards travelers in particular. Most questions had to do with air or car travel.
Scoring system: Style	No results
Scoring system: Clarity	No results
Graphic appeal	Tastefully colored form. Colorful, high-contrast interface using shades of green and sky blue.
Results	No results
Appropriateness of advice	No advice
Direction of questions	Quiz stays the same regardless of response. Each category of resource use gets its own page, but there is no communication

	between the pages.
Emotional appeal	Feel bored/no emotion
Bug-free	Fatal errors. Popup error when processing results

11B GLOBAL FOOTPRINT NETWORK

Category	Score
Ease of use	Could answer all questions easily . There was a way to give either vague sliding-scale answers or numerical ones.
Intended audience	Teenagers (13-18) . Edgy without being condescending. I took the quiz acting as a teenager and could answer all of the questions
Scoring system: Style	Graphs . Showed a bar graph of acres I'd need of each kind of land to support my life
Scoring system: Clarity	Clear . Read like a price tag: if you want this, it takes this much
Graphic appeal	Multimedia . Popping noises for questions, and a 'good' or 'bad' chime on responses
Results	Average . 6.3 Earths, 27.9 acres, 35.6 tons carbon dioxide, mostly in the mobility category

Appropriateness of advice	Short list of generic advice. Obviously not tailored. First piece of advice: Eat less meat. I rarely eat meat, and said so
Direction of questions	Quiz keeps running total of responses . Running total of resource use represented as how urban the background became
Emotional appeal	Feel inspired to do better . "I've slipped. I hadn't noticed."
Bug-free	Started with difficulty

11C ECOLOGYFUND.COM

Category	Score
Ease of use	Could answer all questions easily. Simple drop down menus
Intended audience	No particular audience. Too short to detect audience. 5 year old could take it.
Scoring system: Style	Highly numerical. Results calculated amount of land to support lifestyle
Scoring system: Clarity	Lack of reference points. No indication of whether results were good or bad
Graphic appeal	Simple form. Black text, white background, plain font

Results	Skewed noticeably high. 7.4 earths, 23.4 acres. The number is a little higher because you can specify how much land be set aside for other species.
Appropriateness of advice	No advice
Direction of questions	Single page of questions
Emotional appeal	Feel smug. "My number is high, but I care about the little animals"
Bug-free	No bugs. Not particularly entertaining

11D COOL CLIMATE CARBON FOOTPRINT CALCULATOR

Category	Score
Ease of use	Could answer a few questions with some trouble. I had to leave most of the questions on default. I keep track of how many meat meals I have per week, not my annual grocery bill.
Intended audience	Typical adults (18+). Clearly oriented towards established families. Annual household income only mean so much when your household only shares kitchen and laundry space
Scoring system: Style	Numerical with a few illustrations. It told me the number of tons of

	carbon dioxide I release in each category.
Scoring system: Clarity	Clear
Graphic appeal	Poorly colored form. Too many different colors and patterns. I appreciate the need for color-coding, but this is extreme
Results	Skewed noticeably low. 27 tons of carbon dioxide. I am average for my area, I use 64% of the resources of other US families, but 320% of the worldwide average.
Appropriateness of advice	No advice
Direction of questions	Quiz keeps running total of responses.
Emotional appeal	Feel bored/no emotion. "Well, that was a waste of time"
Bug-free	No errors

11E PERSONAL EMISSIONS CALCULATOR

Category	Score
Ease of use	Could answer most questions with some trouble. Asked for very specific amounts. I don't know what kind of heat I use, or how many

	kWhs
Intended audience	Managers/Professionals. Meant for homeowners
Scoring system: Style	Highly numerical. No pictures at all
Scoring system: Clarity	Lack of reference points
Graphic appeal	Tastefully colored form. In official blues and grays
Results	Skewed noticeably low. 27.7 tons carbon dioxide
Appropriateness of advice	Advice list completely tailored. Based on the amount of driving I do, it suggested possible new cars. Since I marked my type of heat as 'oil', it listed possible alternatives.
Direction of questions	Single page of questions
Emotional appeal	Feel bored/no emotion. "This is so official. Am I applying for a tax credit or something?"
Bug-free	No errors

11F WWF ECOLOGICAL FOOTPRINT

Category	Score

Ease of use	Could answer most questions with some trouble. It used British measurements, and had too wide a gradation between responses. I eat fish once every other week, while my choices were never and weekly.
Intended audience	No particular audience. Not Americans
Scoring system: Style	Visual representation with a few numbers. Results represented by space around figure
Scoring system: Clarity	Condescending. I was scolded
Graphic appeal	Animated. Wipe transition between slides
Results	No results. 5.1 hectares
Appropriateness of advice	Plenty of generic advice. Long list of pledges
Direction of questions	Quiz stays the same regardless of response
Emotional appeal	Feel resentful and insulted. "So Europeans use half of what Americans do. What should I do, move to Europe? And how am I supposed to control the amount of junk mail I get, precisely? I've been trying for years."
Bug-free	Few inconsequential errors. Had to click twice sometimes

11G CONSUMER CONSEQUENCES

Category	Score
Ease of use	Could answer all questions easily
Intended audience	Very young children (3-9). A little too cutesy, but probably a good introduction for kids
Scoring system: Style	Graphs
Scoring system: Clarity	Condescending. I know that using less earths is good.
Graphic appeal	Multimedia. Fills in the neighborhood based on how far along the quiz is.
Results	Skewed much lower than average. 4.4 earths. Maybe they're counting ocean land as usable?
Appropriateness of advice	Advice list completely tailored. Each response gives its own piece of advice, with congratulations if you do well
Direction of questions	Quiz keeps running total of responses. Tracks how many earths you would need
Emotional appeal	Feel bored/no emotion. Not a flaw with the quiz, just the wrong audience

Bug-free	No errors.
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11H THE NATURE CONSERVANCY

Category	Comments
Ease of use	Could answer all questions easily. Almost all questions had alternate options
Intended audience	Typical adults (18+)
Scoring system: Style	Graphs
Scoring system: Clarity	Clear
Graphic appeal	Tastefully colored form
Results	Average. 31 tons of carbon dioxide, mostly in travel
Appropriateness of advice	Irrelevant/out-of-date advice. Sold offsets
Direction of questions	Quiz stays the same regardless of response
Emotional appeal	Feel guilty, driven to improve. Probably the goal
Bug-free	No errors.

111 AN INCONVENIENT TRUTH

Category	Comments
Ease of use	Could answer most questions easily. Heating bill is a little tricky
Intended audience	No particular audience. Too short to notice an audience
Scoring system: Style	Highly numerical. Just told me my carbon emissions
Scoring system: Clarity	Condescending. There's a whole page devoted to how the results were calculated for each response
Graphic appeal	Poorly colored form. Strange little black and white layout
Results	Skewed much lower than average. 12.2 tons carbon dioxide. That's less than half of last time
Appropriateness of advice	Short list of generic advice
Direction of questions	Single page of questions
Emotional appeal	Feel entertained/no emotion. Fun, but not meaningful. I think the quiz needs to be less generic
Bug-free	No errors

11J TERRAPASS CARBON FOOTPRINT CALCULATOR

Category	Score
Ease of use	Could answer all questions easily. Default button for the lazy/uninformed
Intended audience	Typical adults (18+)
Scoring system: Style	Numerical with a few illustrations
Scoring system: Clarity	Clear
Graphic appeal	Tastefully colored form. Blue on dark blue. Classic
Results	Average. 31 tons of carbon dioxide emissions. Costs \$190.40 per year to repair
Appropriateness of advice	No advice, unless you count "buy offsets"
Direction of questions	Quiz stays the same regardless of response
Emotional appeal	Feel smug. That's all it costs to live my way? That's less than a week's work.
Bug-free	No errors.

12 APPENDIX 2: PILOT STUDY

This survey was informally given to a convenient sampling on campus:

COLLEGE STUDENT SURVEY

This survey should assess how much resources students actually use, so the quiz can focus on the most important issues.

HOME

The place I live is:

- ☐ Warm
- ☐ Medium
- ☐ Cold

Local buildings are most likely heated with some kind of fossil fuel. Because oil is produced so slowly, it has a high environmental footprint associated with it.

I have an oven (and use it)

- ☐ Yes
- ☐ No

Offsetting the energy fueling, making, and disposing of a stove is the ability to use locally-grown food. Food that can be cooked without an oven is usually thickly packaged. There is the ecological damage of the packaging itself, as well as the energy involved in transporting it from the factory.

I have a microwave/fridge

☐ Yes

☐ No

This question runs in roughly the same vein as the above question.

I have a widescreen TV

☐ Yes

☐ No

College students don't necessarily have access to electricity bills. This question is designed as an indicator of electricity use.

I do my laundry

☐ Daily

☐ Weekly

☐ When I have a full load

☐ Never. Someone else does.

College students also might not know how much water they use. This will serve as an approximate indicator.

FOOD

I eat meat

☐ At every meal

☐ Daily

☐ Some days

☐ Never/Rarely

This is a standard question on the footprint surveys I studied. Because meat has a higher environmental impact than other foods, the land spent supporting a student's diet is higher for meat than vegetables.

I eat packaged food

☐ At every meal

☐ Daily

☐ Some days

☐ Never/Rarely

Packaged food has a triple impact above the food itself: first, the packaging needs to be made, then it needs to be shipped from the factory, then the packaging needs to decompose.

I eat out-of-season produce

☐ At every meal

☐ Daily

☐ Some days

☐ Never/Rarely

This also relates to the energy required to grow food. Out-of-season food needs to be either shipped or grown in a greenhouse. Shipping food requires oil to transport and electricity and chemicals to keep it fresh, while forcing food requires fertilizers, heaters, and space.

VEHICLE

I use ___ gallons of gas per week

-or-

I fill my tank every ___ days

-or-

I get ___ mpg and drive ___ miles per week

-or-

o I use an alternative fuel

o I don't have a car

This is the largest variable in this survey. Food and shelter are requirements, but not every student has a car, and those that do may use it for a mile a week or a hundred.

MAJOR

I'm majoring in: (list all)

1. _____

2. _____

3. _____

This question is for statistical purposes. I also want to find if there is any correlation between academic field and environmental impact.

13 APPENDIX 3: CALCULATIONS AND ASSUMPTIONS

13A: HOW MUCH MEAT DO YOU EAT?

'At every meal' means that you eat three 3 oz portions of some kind of beef, poultry, or pork product a day, on average. 'Daily' means you eat one 3 oz portion of meat a day, on average. 'Some days' means you eat a serving of meat more often than once a week, but not daily. Finally, 'Never/Rarely' means you eat meat less than once a week.

Because meat has a higher environmental impact than other foods, the land spent supporting a student's diet is higher for meat than vegetables.

- A serving of meat is 3 oz. (Davis)
- Of the meat consumed in the United States, 31.7 kg/c was pork, 49.4 kg/c was chicken, and 45.3 kg/c was beef. For simplification, consumption of other types is negligible.
(Coutsoukis)
- Each Kcal of pork releases 9.03g CO₂ into the atmosphere. Each Kcal of chicken releases 1.67g CO₂. Each Kcal of beef releases 13.82g CO₂. (Eshel and Martin)
- There are 55 Kcal in each ounce of lean meat. For simplification, assume that is the only kind of meat produced. (Food Exchange List)

So, extrapolating from (2), of the meat consumed in the United States,

$31.7/(31.7+49.4+45.3)=25.1\%$ was pork, $49.4/(31.7+49.4+45.3)=39.1\%$ was chicken, and $45.3/(31.7+49.4+45.3)=35.8\%$ was beef.

From this, a generic 'meat' can be inferred that costs $(25.1 \times 9.03) + (39.1 \times 1.67) + (35.8 \times 13.82) = 7.87$ g CO₂/Kcal

So, a serving of meat has $3\text{oz} \times 55\text{Kcal/oz} \times 7.87\text{g/Kcal} = 1.30\text{kg CO}_2$

The first response implies $1.30 \times 3 \times 365 \times 2.20 = 3124$ lbs/year. The second response implies $1.30 \times 1 \times 365 \times 2.20 = 1045$ lbs/year. The third response implies $1.30 \times 52 \times 2.20 = 149$ lbs/year. The fourth response implies 0 lbs/year.

13B: HOW MUCH NONLOCAL PRODUCE DO YOU EAT?

'At every meal' means that you eat three servings of out-of-season produce, on average. 'Daily' means you eat one serving of out-of-season produce a day, on average. 'Some days' means you eat a serving more often than once a week, but not daily. Finally, 'Never/Rarely' means you eat out-of-season less than once a week.

This question also relates to the energy required to grow food. Out-of-season food needs to be either shipped or grown in a greenhouse. Shipping food requires oil to transport and electricity and chemicals to keep it fresh, while forcing food requires fertilizers, heaters, and space.

- Ecuador produces bananas; Jacksonville, FL produces oranges; and Yuma, AZ produces lettuce. Assume these are representative samples of nonlocal food.
- Ecuador is 3000mi from Worcester. Jacksonville is 1100mi from Worcester. Yuma is 2800mi from Worcester. (MapQuest)
- Diesel fuel releases 22.2lbs/gallon of CO₂ (United States Environmental Protection Agency)
- Diesel trucks get 5.7 mpg, on average (Energy Information Administration)

- The maximum hauling capacity of a semi-trailer truck is 164 tons. Assume a reasonable working estimate is 100 tons of cargo (Semi-trailer Truck)
- A serving of fruit is about 1/4lb (Jegtvig)

So, hauling a ton of fruit releases $22.2/5.7/100=0.0389$ lbs CO₂ per mile.

Hauling a ton of bananas releases 117lbs CO₂, hauling a ton of oranges releases 42.8lbs CO₂, and hauling a ton of lettuce releases 109lbs CO₂.

If consumption is spread evenly, each pound of produce releases

$(117+42.8+109)/3/2000=0.0448$ lbs CO₂

The first response implies $3/4*365*0.0448=12.26$ lbs CO₂ per year. The second response implies $1/4*365*0.0448=4.088$ lbs CO₂ per year. The third response implies $1/4*52*0.0448=0.582$ lbs CO₂ per year. The last response implies 0lbs CO₂/year.

13C: WHERE DO YOU LIVE?

Each of the different residence halls uses different amounts of resources to stay heated. Some are better insulated, and some have finer control over the heating system.

- East Hall used 78914 Kwh to power 192 residents for 4 months, for an average annual electricity use of 1233 Kwh.
- No data is available for Morgan or Daniels Hall, but they are expected to be similar to Founders based on similar layout, age, and occupancy.
- Institute Hall used 57120 Kwh to power 66 residents for 4 months, for an average annual electricity use of 2596 Kwh.

- No data is available for Ellsworth-Fuller Apartments, but it is expected to be similar to Stoddard Complex based on similar layout, age, and occupancy.
- Stoddard Complex used 200400 Kwh to power 154 residents for 4 months, for an average annual electricity use of 3904 Kwh.
- Founders Hall used 421760 Kwh to power 232 residents for 4 months, for an average annual electricity use of 5454 Kwh.
- No data is available for Sanford-Riley Hall, but it is expected to be similar to Founders based on similar layout, age, and occupancy. (Tomaszewski)
- There are three energy suppliers for this area: Dominion Retail, Easy Energy, and MXENERGY. (Energy Supplier List)
- Dominion Retail sells from 15.5% coal, 34.7% natural gas, 7.5% oil, 28.6% nuclear, and 13.7% from other sources. (Dominion Retail)
- Easy Energy sells from 12% coal, 8% hydroelectric, 27% natural gas, 16% oil, 32% nuclear, and 5% from other sources. (Easy Energy of Massachusetts)
- Coal releases 207.91 lbs CO₂ per mmBtu. Natural gas releases 116.39 lbs CO₂ per mmBtu. Oil releases 159.66 lbs CO₂ per mmBtu. (United States Environmental Protection Agency)

No disclosure label was available from MXENERGY, so assume that the two that had labels are representative. Also assume the two companies have equivalent market share. Finally, assume hydroelectric and nuclear power are carbon-neutral.

The energy is, on average, 13.8% coal, 4% hydroelectric, 30.8% natural gas, 11.7% oil, 30.3% nuclear, and 9.4% other.

So, there are 83.2 lbs CO₂ released per mmBtu.

There are 3412 Btu per Kwh, and 10^6 Btu per mmBtu. So, there are 0.284 lbs CO₂ released from a Kwh of electricity.

East implies 350 lbs CO₂, Morgan, Daniels, Founders, and Sanford-Riley imply 1550 lbs CO₂, Institute implies 737 lbs CO₂, and Ellsworth-Fuller and Stoddard imply 1110 lbs CO₂.

13D: HOW WARM IS YOUR HOME?

'Hot' refers to room temperature above 70 degrees, 'Warm' refers to room temperature between 65 and 70 degrees, 'Cool' refers to room temperature between 60 and 65 degrees, and 'Cold' refers to room temperature below 60 degrees.

Local buildings are heated with fossil fuel. Because fossil fuels are created so slowly, it has a high environmental footprint associated with it.

- WPI is heated with natural gas. (Tomaszewski)
- Natural gas releases 116.39 lbs CO₂ per mmBtu. (United States Environmental Protection Agency)
- East Hall uses 69150 therms (Tomaszewski)

Assume East Hall is representative of the dorms. There are 10^5 Btu per therm, so heating a building results in 805000 lbs CO₂ per year for the building.

For each of the 192 residents, that means 4192 lbs CO₂ per year.

13E: HOW MUCH GASOLINE DOES YOUR CAR USE?

Cars run on gasoline, a high-carbon fuel.

Each gallon of gasoline releases 19.37 lbs CO₂. (United States Environmental Protection Agency)

Assume that alternative fuels and those without cars create no greenhouse gases in this category.

For the first part, the number of gallons can be multiplied by $52 \times 19.37 = 1007$ to get the number of pounds CO₂.

For the second part, assuming a 12-gallon tank, $19.37 \times 12 \times 365 = 84840$ should be divided by the number of days to get the amount of CO₂.

For the third part, the distance should be divided by the mpg, then multiplied by $19.37 \times 52 = 1007$.

13F: HOW MUCH JET FUEL DO YOU USE?

Flights are round-trip. A long flight is equivalent to a New York-Tokyo flight. A medium flight is equivalent to a New York-Los Angeles flight. A short flight is equivalent to a Boston-Washington flight.

Flights take far more energy to take off and land than to fly, so they follow a different model than cars.

- A long flight releases 15714 lbs CO₂.
- A medium flight releases 5546 lbs CO₂.
- A short flight releases 1327 lbs CO₂. (Choose Climate: Flying off to a Warmer Climate?)

Assume the flight was made on an 80% capacity Boeing 747.

The amount of CO₂ released is the sum of the number of each kind of flight times the amount of CO₂ released.

14 APPENDIX 4: BETA TEST

14A APPENDIX 4A: IRB APPLICATION



WORCESTER POLYTECHNIC INSTITUTE
Institutional Review Board
Application for Exemption from IRB Review for
Survey or Interview Research Involving Minimal or No Risk

WPI IRB use only

IRB # _____

Date: _____

Use of this application is recommended for most student project research involving minimal risk. Proposed research meets the definition of "minimal risk" when the risks to research subjects are not greater than those ordinarily encountered in daily life. This application is specifically intended for projects in which students are expected to conduct interviews, surveys or focus groups. If student projects are sponsored by US federal agencies, students and advisors should contact the IRB for assistance in filing a full application with the New England IRB.

Project Faculty Advisor(s):

Name: James K. Doyle Tel No: X5583 E-Mail Address: doyle@wpi.edu
Department: _____

Name: _____ Tel No: _____ E-Mail Address: _____
Department: _____

Student Investigator(s):

Name: Caitlin Vandyke Tel No: 401-651-2012 E-Mail Address: cvandyke@wpi.edu
Name: _____ Tel No: _____ E-Mail Address: _____
Name: _____ Tel No: _____ E-Mail Address: _____
Name: _____ Tel No: _____ E-Mail Address: _____

Project Title: WPI's Environmental Footprint

Project Location and Time Frame: on campus, D term 09

Expected Research Subjects: (e.g. museum visitors under the age of 12)

Psychology Research Participation Pool

NOTE: This application must be accompanied by written research methods and a reasonably complete set of survey or interview questions.

1. Is the proposed research sponsored or supported by a US federal agency or by US government funding? No ☒ Yes ☐
2. Is the proposed research funded by a corporation or foundation?
If so, please identify sources. No ☒ Yes ☐
3. Does the proposed research involve vulnerable research subjects? (e.g. children, prisoners, students, persons with mental or physical disabilities, pregnant women) No ☒ Yes ☐

**WPI IRB Application for Exemption from IRB Review for
Survey or Interview Research Involving Minimal or No Risk**

- | | |
|--|---|
| 4. Is the research confined to obtaining verbal or written information from subjects and/or publicly available documentary information? | No ☐ Yes ☒ |
| 5. Could the disclosure of a human subject's identity and responses place the subject at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation? | No ☒ Yes ☐ |
| 6. Will the researchers collect information that can be used to identify the subjects? | No ☐ Yes ☒ |
| 7. If the researchers do know the subjects' identity, will individual responses be kept confidential? (e.g. only summaries of all data will be published) | No ☐ Yes ☒ |
| 8. Will researchers be interviewing people chosen because of their expertise or experience? (See 4, below.) | No ☒ Yes ☐ |

By signing below, all participants in this research project are agreeing to follow the following instructions:

1. You agree to inform subjects orally or in writing that:
 - Participation in the research is voluntary.
 - Participants may end their participation at any time.
 - Participants need not answer every question in an interview or survey.
2. If your research is **anonymous**, you also inform subjects that you are not collecting names or any identifying information from them.
3. If your research is **confidential**, you inform subjects that no identifying information will be disclosed with individual responses.
4. If your research subjects are chosen and interviewed for their expertise or experience, you seek and obtain each subject's permission to identify him or her in your report, and obtain each subject's permission to disclose his or her views and statements in your report. The subject must be offered the opportunity to pre-approve the publication of any quoted material. If a subject does not wish to appear in your report, you respect his or her wishes for confidentiality.

Signature of Faculty Advisor

James K. Doyle

Date 3/26/09

Print Full Name and Title

James K. Doyle, Assoc. Prof. of Psychology

Please return a signed hard or electronic copy of this application to the WPI IRB c/o Office of Sponsored Programs or irb@wpi.edu.

If you have any questions, please call (508) 831-6716.

Please answer as many of these questions as fully as you can.

Ease of use:

1	2	3	4	5	6	7	8	9	10
Impossible		...	Some trouble		...	Easy	...	Very Easy	

Appropriateness of questions:

1	2	3	4	5	6	7	8	9	10
Irrelevant		...	Slightly off-topic		...	Relevant	...	Very Relevant	

Clarity of questions:

1	2	3	4	5	6	7	8	9	10
Made no sense		...	Confusing		...	Fine	...	Very Clear	

Clarity of scoring:

1	2	3	4	5	6	7	8	9	10
Made no sense		...	Confusing		...	Fine	...	Very Clear	

Graphic appeal

1	2	3	4	5	6	7	8	9	10
Ugly		...	Boring		...	Fine	...	Beautiful	

Emotional appeal

1	2	3	4	5	6	7	8	9	10
Mind-numbing		...	Boring		...	Fun	...	Addictive	

Did you run into any technical problems? Please describe them here:

Do you have any suggestions to improve the quiz?

14C APPENDIX 4C: INFORMED CONSENT FORM

Investigator: Professor James Doyle, Caitlin Vandyke

Contact Information:

James Doyle, doyle@wpi.edu

Caitlin Vandyke, cvandyke@wpi.edu

Title of Research Study:

A9: "Environmental Footprint Pilot Study"

Introduction

You are being asked to participate in a research study on the ease of use of a new environmental footprint quiz designed for WPI students. You can help by completing the quiz and answering a few questions afterwards about your experience. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study: This survey is a beta test to determine the focus and effectiveness of an environmental footprint quiz targeted towards WPI students.

Procedure:

1. There will be several sessions to participate in. These will be held in the ADP lab, on the bottom floor of Fuller Labs. Attend whichever one is most convenient.
2. At the beginning of the session, go to users.wpi.edu/~cvandyke/quiz
3. Try out the quiz found there. You can try it a few times if you like. Record your answers on the sheet given to you.
4. When you finish the quiz, you will be given an evaluation to fill out.
5. Please answer the questions there to the best of your ability.
6. When you are done, return both the answer sheet and the evaluation.
7. A researcher will be available for questions, however it is recommended to try to figure out as much as possible yourself, and note the confusing area on the evaluation.

Risks to study participants:

The risks involved in this study will be minimal.

Benefits to research participants and others:

There are no direct benefits to you for participating in the study; however, there may be significant benefits to the community as a whole. The quiz may be presented to the WPI community, where it will be made available to all students, to help them understand the environmental impact of their choices here. With that information, they may be able to make more informed choices with respect to energy and resource use.

Record keeping and confidentiality:

No identifying information will be solicited in the study. If you leave any responses that might identify you personally, please keep the following in mind:

Records of your participation in this study will be held confidential so far as permitted by law.

However, the study investigators, the sponsor or its designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

For more information about this research or about the rights of research participants, contact:

James Doyle: Contact information above

Professor Kent Rissmiller, IRB Chair: Tel. 508-831-5019, Email: kjr@wpi.edu

Michael J. Curley, Tel. 508-831-6919, Email: mjcurley@wpi.edu

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. You may refuse to answer any particular question in either the quiz or the evaluation. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

_____ Date: _____

Study Participant Signature

Study Participant Name (Please print)

_____ Date: _____

Signature of Person who explained this study



CERTIFICATE OF COMPLETION

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Caitlin Vandyke** successfully completed the NIH Web-based training course “Protecting Human Research Participants”.

Date of completion: 01/15/2009

Certification Number: 142330



14E APPENDIX 4E: IRB APPROVAL LETTER



Department of
Social Science
and Policy Studies

100 Institute Road
Worcester, MA 01609-2280, USA
508-831-5296, Fax 508-831-5896
www.wpi.edu

31 March 2009
File: 2009-EX-049

Worcester Polytechnic Institute
100 Institute Road
Worcester, MA 01609

Re: IRB Application for Exemption 2009-EX-049: "WPI's Environmental Footprint"

Dear Professor Doyle,

The WPI Institutional Review Committee (IRB) has reviewed the materials submitted in regards to the above mentioned study and has determined that this research is exempt from further IRB review and supervision under 45 CFR 46.101(b)(2): "Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation."

This exemption covers any research and data collected under your protocol from 31 March 2009 until 30 March 2011, unless terminated sooner (in writing) by yourself or the WPI IRB. This approval becomes immediately null and void if this project receives any federal sponsorship and work on this study must cease until review and approval by New England IRB. Amendments or changes to the research that might alter this specific exemption must be submitted to the WPI IRB for review and may require a full IRB application in order for the research to continue.

Please contact the undersigned if you have any questions about the terms of this exemption.

Thank you for your cooperation with the WPI IRB.

Sincerely,

Kent Rissmiller
WPI IRB Chair