Curriculum for the Bioregion[1]

Developing a Transportation Survey to Estimate Gasoline Use by Campus Commuters

A teaching-and-learning activity for a liberal arts mathematics class.

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Summary

Through this activity, students will develop experience with real-world statistical concepts through the context of sustainability: estimation, survey writing, sampling techniques, and data analysis.

Students will read an overview of the ideas of greenhouse gas inventories and climate action plans. They will draft a transportation survey with the goal of estimating gasoline use by campus commuters (an important component of a greenhouse gas inventory). Through class discussion, students will use their drafts to create a model transportation survey. They will create several implementation plans for the survey based on differing levels of practicality and support. Although students will not necessarily implement the survey, they will take it themselves and compile data and conclusions from the class.

Learning Goals and Big Ideas

Students will become familiar with the following: sustainability; transportation survey; cooperative group work; guided class discussion; possibly group data collection.

"Big Ideas": estimation; data collection; data presentation in the context of greenhouse gas emissions.

Context for Use

[1] *The Curriculum for the Bioregion is an initiative of the Washington Center for Improving the Quality of Undergraduate Education at The Evergreen State College. This "teaching and learning activity" is one of several developed by a faculty learning community in math in February, 2010.*

This activity is intended for a liberal arts mathematics class (such as Math 107: Math in Society), although it could be used in an introductory statistics class. Students will be exposed to a large, messy, real-world problem without an "answer in the back of the text." Students will have to think about basic concepts like estimation and units of measure to get a handle on the goals of a greenhouse gas inventory. Students will apply statistical concepts to develop a workable transportation survey and implementation plan and then to analyze class data.

For a liberal arts mathematics class (such as Math 107: Math in Society), this project would take two or three days, with critical homework each night. However, the activity has several parts that could be used individually for a one-day activity. Before this activity, students should have developed some skills in working with numbers in the real world (e.g. estimation, uses and abuses of percentages, scientific notation), but don't need to have learned any statistics. However, if students have not yet learned any statistics, the activity will have to be done in segments with some lessons on basic statistics in between each segment.

Description and Teaching Materials

Preparatory Reading:

The Author's Preface, Section 1, and Section 4.1 (including all subsections) from Cool Campus! A How-To Guide for College and University Climate Action Planning (www.aashe.org/files/resources/cool-campus-climate-planning-guide.pdf).
Note: If your campus has a Climate Action Plan, have students read it (or portions of it).

Class and Homework Activities

(Homework) Students read about greenhouse gas inventories and campus climate action plan.

(In Class) A brief discussion of the introductory readings and goal of the transportation survey.

(Homework) Students draft transportation surveys.

(In Class) In groups, students refine surveys, then, through discussion, the entire class develops a model transportation survey. **(In Class)** Begin discussion of implementation methods. Introduce idea of sampling and give examples in other contexts. Return to implementation methods discussion.

(Homework) Student complete survey.

(Homework) Students summarize pieces of data.

(In Class) Students analyze survey data and determine an appropriate way to present analysis.

Part I: Planning a Transportation Survey

Homework Questions for Students to Turn In:
(1) Why is a greenhouse gas inventory important for our college?
(2) What information would we need in order to determine the total number of gallons of gasoline consumed by commuting to the college?
(3) What is a Climate Action Plan?

Short Class Discussion on measurements needed to estimate gasoline used in commuting.
Students should be clear that they need to measure or estimate miles driven and fuel economy of cars used for commuting; that students and employees need to be included; and, that buses need to be accounted for. Students may be interested in gathering information about commuters who bike or walk, although these activities don't generate greenhouse gas emissions. Focus this discussion on what information is needed, not on how to gather that information.

Homework Activity for Students to Turn In:
Create a draft of a transportation survey that would allow you to reasonably estimate the number of gallons of gasoline that is consumed in commuting to the college.

Considerations:

(1) Ask questions that get the pieces of data you need to achieve your goal.

(2) Ask questions most people will be able to answer accurately.

(3) Ask questions most people will be willing to answer.

(4) Ask a reasonable number of questions so most people will take the time to complete your survey.

In-Class Group Activity for Students:
In groups of three or four people, share your draft transportation surveys. Critique each draft, using the considerations from last night's homework activity.

(1) Would the survey results allow you to reasonably estimate the number of gallons of gasoline that is consumed in commuting to your college campus?

(2) Can each member of the group answer the questions on the survey?

(3) Would each member of the group be willing to answer all the questions on the survey?

(4) Would each member of the group take the time to answer all the questions on the survey?

On each draft, in a few sentences write a critique describing the strengths and weaknesses of the draft. Then combine your drafts into a single survey for your group. Write this new survey on a separate piece of paper. Turn in all the drafts (with critiques) and your new survey.

Class Discussion:
Have as many groups as possible present their surveys and either pick the best (perhaps modifying it) or combine them.

Part II: Planning Implementation of a Transportation Survey

Class Discussion:
Start a class discussion on implementation plans. Students may want to take a census, using mail, email, or in-class or online surveys. Make a list of ideas and after students have named several ideas, ask them to think about feasibility – what resources are needed for each plan? What are the under-coverage issues in each plan? What are the non-response issues in each plan?

Continuing Class Discussion:
If students haven't come up with the idea of sampling, introduce it along with different sampling methods (e.g. simple random sample, stratified sampling, cluster sampling, systematic sampling, voluntary response sampling, convenience sampling).

In groups, have students create implementation plans for several different types of sampling, as well as for a census. After groups have drafted some plans, have them evaluate each plan based on resources needed and possible undercoverage and nonresponse issues. Plans might be grouped according to whether:

(a) students could implement them with minimal cost (besides volunteer time and some paper or photocopies that the instructor could provide);

(b) students could implement them but would need a few resources from college employees besides the instructor; or

(c) students couldn't implement without a lot of support and resources from the college.

At this point students can compare the class survey to surveys from previous classes and to surveys actually used at their college or other colleges. Some examples are at http://www.aashe.org/blog/guidance-

scope-3-emissions-pt-1-commuting. If students and instructor are interested, the students could implement the survey. This could be part of a service-learning project coordinated with college employees working on sustainability.

Part III: Working with Survey Results

The instructor will type up the final survey created by the class and have the class take it (possibly online). Compile and distribute raw data. Have students use the results to estimate the number of gallons of gasoline used by the class in commuting to the college. After a classroom lesson on basic statistical calculations and graphics, for homework have students (individually or in groups) prepare summary calculations (e.g. mean, median, quartiles, standard deviation) and graphics (e.g. bar graph, pie chart, histogram) for different survey questions. Use summary calculations to estimate gasoline usage and compare this estimate to the calculation from the raw data. Then compare the class's estimate to estimates from previous classes or from other campus documents, such as the Climate Action Plan or Sustainability Committee reports.

Teaching Notes and Tips

In a small Math 107 class I tried a mini-version of this activity – a homework assignment on drafting a transportation survey and a class discussion on the survey and implementation methods. When we discussed implementation, students focused on performing a census and didn't think about sampling.

Assessment

Included in the assignment are considerations for students, which can be used by instructors as rubrics. My liberal arts mathematics class has a lot of group work and short homework writing assignments for which I use a simple grading system:

(a) full credit for a student who completes the assignment completely and reasonably thoughtfully, although not necessarily perfectly;

(b) three-quarters credit for a student who has put some thought into the assignment and who has done a reasonable amount of work but has not completed the assignment or has made a large error or has obviously not taken into account some considerations listed; and,

(c) half-credit (still a 0.0 grade, but not zero credit) for a student who turns in something that shows at least a minimum of thought and effort. I would use this system to assess their draft surveys and implementation plans.

Assessing calculations and graphs is easier so I would use a finer grading scale, probably out of ten points. In my system, to earn 10 points a student must go beyond my expectations and produce work that shows extra effort or insight (as

well as being correct). A standard correct paper earns 9 points, since 90% is the lowest percentage corresponding to a 4.0 grade.

References and Resources

- www.aashe.org/files/resources/cool-campus-climate-planning-guide.pdf
- http://www.aashe.org/blog/guidance-scope-3-emissions-pt-1-commuting
- If your campus has a Climate Action Plan, have students read it. The University of Washington's Climate Action Plan is available at http://f2.washington.edu/oess/sites/default/files/file/UW%20Climate%20Action%20Plan%2010_9.pdf