



Curriculum for the Bioregion¹

Clothes Washers Life Cycle – Cost and Environmental Performance

A cross disciplinary teaching-and-learning activity for intermediate algebra and business students.

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Summary

This is a cross-disciplinary project between students in Intermediate Algebra and business students in Green Purchasing at Everett Community College. The classes work together in groups to numerically evaluate and compare the cost and environmental performance of different clothes washers on the consumer market. Students use statistical data from consumer, national government, and their county and city websites.

Short Description

Students in math and business classes work together in groups to evaluate and compare cost and environmental performance of different clothes washers.

Learning Goals and Big Ideas

- Math students assist business students in the Green Purchasing class in choosing a clothes washer by using mathematics.
- Students have an opportunity to relate their mathematical experiences with real-world decision making.
- Business students consider environmental and social impacts on top of traditional purchasing/procurement criteria when considering the acquisition of goods and services for an organization.

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.*

- Students will consider multiple environmental variables as an integral part of a purchasing process.

Context for Use

The Green Purchasing class provides learning experiences that help business students consider environmental and social impacts on top of traditional purchasing/procurement criteria when considering the acquisition of goods and services for an organization. Such a decision making process involves multiple environmental variables that should be considered as an integral part of the standard purchasing process. While students in this class have solid knowledge of the combination of variables to consider in their evaluation, choosing the best performing product demands a level of mathematical complexity beyond their capacity.

The Intermediate Algebra class is a standard algebra class that focuses on algebraic reducing radicals, solving and simplifying different types of equations, and the like. Traditionally, there has been no applied content in this class beyond a smattering of the standard word problems.

Description and Teaching Materials

For this project students will turn in one assignment for the whole group.

- Students will calculate the life-cycle cost of a clothes washer given certain *inputs*.
- Students calculate the total carbon emissions for a clothes washer given certain *inputs*.
- Students create a spreadsheet which will produce the life-cycle cost and yearly carbon emissions for a clothes washer if you enter the given inputs.
- Students create a graphical analysis of the different Washington machines – something that is easy for a layman to read.

1) Initial Research and Preparation –

- **To Intermediate Algebra** students handout “**Project Outline for Math Students**” (Word Document)
It includes the first phase of the assignment “*Background Research*”
- **Green Purchasing** students
Using the Energy Star website, each student picks three different clothes washer models of similar size.
Research life cycle costs and environmental impacts during use.

2) **First Team Interaction**

Worksheets for **Algebra** students – **“Meeting with Business Students”** (Word Document);
and, **“Group Contract”** and **“Peer Evaluation Form”** (Word Documents)

- **Intermediate Algebra**
Receive visit from Green Purchasing students.
Discuss follow up questions.
- **Green Purchasing**
Report some life cycle components:
 - a) Cost: Retail price, water, sewage, electricity.
 - b) Environmental impact: Water use, electricity use, capacity, CO₂ emission factor for local utility.

3) **Calculation and Reporting**

Worksheet: **“Do The Math”**– (Word Document)
Also, **“Example Math Problem_Lifecycle Cost of Auto”**

- **Intermediate Algebra**
Created equations using real data to which have inputs specific to the washer, and outputs the Environmentally Preferable Purchasing criteria:
 - c) Cost
 - d) CO₂ emissions
- **Green Purchasing**
Provide follow up and assistance, if necessary.

4) **Second Team Interaction**

Worksheet: **“Create the Presentation”** – (Word Document)

- **Intermediate Algebra**
Report finds (calculations and graphs) to Green Purchasing counterparts.
Request final verdict and signature.
- **Green Purchasing**
Review findings and decide on a winning product.
Signed off results.

5) **Meet with Your Business Liaison for a Decision**

- **Intermediate Algebra**
Professor reviews mathematical accuracy and quality of work.

- **Green Purchasing**
Professor reviews overall consistency and quality of work.

6) **Turn It In**
Use the “**GPP Turn-In-Checklist**” – (Word Document) as your guide.

Attachments

Worksheets

1. **Project Outline for Math Students_1** –(Microsoft Word)
2. **Worksheet for Math Students Meeting with Business Students_2** Students --(Microsoft Word)
3. **Group Contract_3** – (Microsoft Word)
4. **Peer Evaluation Form_4** – (Microsoft Word)
5. **Example Math Problem -- Life-Cycle Cost of Automobile_5** (Microsoft Word)
6. **Calculating and Reporting_ Do The Math_6** – (Microsoft Word)
7. **Create The Presentation_7** -- (Microsoft Word)
8. **GPP Turn-In-Checklist_8** – (Microsoft Word)

Teaching Notes and Tips

Christopher Quarles, Intermediate Algebra Professor:

- The algebra students had an opportunity to see equations which represented very real values. For instance, the price of electricity and the amount of CO₂ emitted per kWh used were coefficients in equations.
- There are a lot of teaching opportunities when you combine math with something concrete like buying a washing machine. For example, a number of students mistakenly made the cost of electricity 100 times larger than it was. This led to an interesting discussion about how the price of electricity would affect the purchasing decision. If electricity was \$8 per kWh, we would all buy the most efficient washers possible.
- The quality of student work varied quite a bit. Generally, they were fairly savvy with Excel software. It would be extremely reasonable to make the spreadsheet a required part of their grade. Before they get into the project, it's important to allocate class time to discuss the basics behind life-cycle cost and CO₂ emissions. If feasible, it would also be a good idea to have students turn in rough drafts.

- In retrospect, clothes washers weren't the best choice of item. The lifetime cost of electricity is fairly small when compared with the purchase price of a washer.
- The primary push of the worksheets is getting the students from the raw ideas of life-cycle cost to actual formulas, spreadsheets, and graphs. I think the worksheet on the autos is important to help students know what is expected of them.
- The project could be ramped up so that the students have to turn in a complete, professional-looking report rather than a combination of worksheets. It depends on how much time and willingness you have.
- This project could be done in an algebra class if your college doesn't have a Green Purchasing class. However, this would require quite a bit more knowledge about life-cycle analysis on the part of the instructor. It would require a bit more legwork as well.
- My favorite part of this project was telling students to use their own judgment, for example in deciding what factors to include in life-cycle cost or whether to use the local or national electricity-based emissions rates. The looks on their faces was priceless. In standard mathematics courses, we don't give students enough opportunity to relate their mathematical experiences with real-world decision making. We can do this by either having the students make (non-black/white) decisions which they use to create mathematics or by using the results of their mathematics to make decisions (like which washing machine to buy). This project does both of those.

Miguel Hernandez, Green Purchasing Professor:

- This was a great opportunity to understand the complexities of creating sustainable products in the business world.
- I underestimated the level of preparation and formality that such project requires in order to have the best possible learning outcome.
- Some variables that I need to consider and study in the future are: both classes should have similar student numbers, similar schedules (day and time) and the students need to have some form of common preparation before meeting for the first time so that their expectations about each other are realistic. Some tools that can serve this purpose are: questionnaires, checklists, readings or videos.
- In general, this was a tremendously successful assignment with great potential for improvement if it is to take place again. I am looking forward to new projects with Professor Quarles' students.

Assessment

For this project:

- Turn in one assignment for the whole group.

- Grades will be assessed as follows:
 - Professionalism, quality of work (30%)
 - Content of work (mathematical, reasoning, etc) (60%)
 - Group evaluations (10%)
 - At the end of the project, your group will be asked to rate the participation of your group members.

See handout for **Peer Evaluation**

References and Resources

- Energy Star website for environmental performance and selection of certified clothes washers.
www.energystar.gov

<http://tinyurl.com/yjo79zn> which is a spreadsheet put out by the Energy Star folks.
 This will take you directly to an Excel spreadsheet about TV purchasing where students can plug in certain *inputs*.
 The idea is to show students what the finished product should like. For complex tasks, it's rather hard to describe in words what you want students to produce without giving them an example.
- Environmental Protection Agency website for a bunch of “metrics” relating to green purchasing.
www.epa.gov/epp/tools/epp_metrics.pdf
- Amazon and Retrevo for retail prices.

www.amazon.com

www.retrevo.com
- Snohomish Public Utility District for electricity, water rates and CO₂ emission factors.

www.snopud.com
- Everett Public Works Department for sewage costs.

<http://www.everettwa.org/default.aspx?ID=77>

- Students can look at their own utility bills, power company websites, and local advertisements to find current prices for power and appliances.