**Subject area/course**: Mathematics/Precalculus

**Grade level/band**: 10-12

**Task source**: Envision Schools

**Optimization Project**

**TEACHER'S GUIDE**

1. **Task overview**:

In this task, students will play the role of an efficiency expert for Fozzils, a company that specializes in making lightweight and compact foldable dishes, bowls, cups, and spoons for camping and backpacking. Students will do an inquiry to figure out the best design for the rectangular and square based products in terms of their dimensions. Students will write a proposal to the company for the ideal design of the dishes along with a mathematical analysis to convince the company.

1. **Aligned standards:**
2. **Primary Common Core State Standards**

Standards for Mathematical Practice:

* Make sense of problems and persevere in solving them
* Reason abstractly and quantitatively
* Model with mathematics
* Use appropriate tools strategically
* Attend to precision

[CCSS.MATH.CONTENT.HSN.Q.A.1](http://www.corestandards.org/Math/Content/HSN/Q/A/1/) Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

[CCSS.MATH.CONTENT.HSN.Q.A.2](http://www.corestandards.org/Math/Content/HSN/Q/A/2/) Define appropriate quantities for the purpose of descriptive modeling.

[CCSS.MATH.CONTENT.HSN.Q.A.3](http://www.corestandards.org/Math/Content/HSN/Q/A/3/) Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

[CCSS.MATH.CONTENT.HSA.REI.D.11](http://www.corestandards.org/Math/Content/HSA/REI/D/11/) Explain why the *x*-coordinates of the points where the graphs of the equations *y* = *f*(*x*) and *y* = *g*(*x*) intersect are the solutions of the equation *f*(*x*) = *g*(*x*); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where *f*(*x*) and/or *g*(*x*) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.\*

[CCSS.MATH.CONTENT.HSF.IF.B.4](http://www.corestandards.org/Math/Content/HSF/IF/B/4/) For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity*.\*

[CCSS.MATH.CONTENT.HSG.GMD.B.4](http://www.corestandards.org/Math/Content/HSG/GMD/B/4/) Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

[CCSS.MATH.CONTENT.HSG.MG.A.3](http://www.corestandards.org/Math/Content/HSG/MG/A/3/) Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios)

1. **Critical abilities**

Analysis of Information**:** Integrate and synthesize multiple sources of information (e.g., texts, experiments, simulations) presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to address a question, make informed decisions, understand a process, phenomenon, or concept, and solve problems while evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

Experimentation and Evaluation**:** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Evaluate hypotheses, data, analysis, and conclusions, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Use of Technology**:** Present information, findings, and supporting evidence, making strategic use of digital media and visual displays to enhance understanding. Use technology, including the Internet, to research, produce, publish, and update individual or shared products in response to ongoing feedback, including new arguments or information.

Modeling, Design, and Problem Solving**:** Use quantitative reasoning to solve problems arising in everyday life, society, and the workplace, e.g., to plan a school event or analyze a problem in the community, to solve a design problem or to examine relationships among quantities of interest. Plan solution pathways, monitoring and evaluating progress and changing course if necessary, and find relevant external resources, such as experimental and modeling tools, to solve problems. Interpret and evaluate results in the context of the situation and improve the model or design as needed.

1. **Time/schedule requirements:**

This task will take approximately 3 weeks to complete. A sample schedule follows:

* 2 days: Project Introduction and setup work
* 1 day: WolframAlpha Boot Camp
* 8-10 days: Computer work time
* Final day: Turn in project proposal/write-up and reflect on project

1. **Materials/resources:**

* Extended computer lab time
* Project Day 1 handout – one copy per student
* WolframAlpha Boot Camp Cheat Sheet handout – one copy per student
* Word-processing software for completing the proposal
* Internet access to access WolframAlpha

1. **Prior knowledge:**

Surface area and volume of rectangular boxes.

1. **Connection to curriculum:**

None listed.

1. **Teacher instructions:**

* Introduce the task by handing out the student prompt and Day 1 Handout.
* Each student in the class will be randomly assigned to investigate one of the rectangular base dishes **and** one of the square base dishes. You can fill out the table below to assign students assignments. Project the matrix on the board to show students which two products they will be investigating for this task.

***Product Assignments***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **PERIOD 1** | RECT 5x7 | RECT 8.5x11 | RECT 8.5x14 | RECT 11x14 | RECT 11x17 |
| SQR 50 |  |  |  |  |  |
| SQR 65 |  |  |  |  |  |
| SQR 80 |  |  |  |  |  |
| SQR 100 |  |  |  |  |  |
| SQR 130 |  |  |  |  |  |
| SQR 150 |  |  |  |  |  |

1. **Student support:**

None listed.

1. **Extensions or variations:**

Ambitious or advanced students could try the same problem with a cylindrical cup: a circle on the bottom and a rectangle wrapped around to create the sides. Minimize surface area for a given desired volume.

1. **Scoring:**

Student work can be scored using the Envision Schools Problem Solving Application (Analysis or Inquiry) rubric.