

Research Experiences for Teachers (RET) – 2014

LESSON PLAN 1

MODULE TOPIC: The Manufacture of Chocolate

OBJECTIVE(S):

Students will be able to:

- Create a design specification for new appliance which includes a detailed drawing and a summary description of its function and usage.
- Design to create a draft patent application.

STANDARD(S) & INDICATOR(S)

NGSS: HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

NGSS: MS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

BACKGROUND

Systems Engineering

In systems for industries:

- Input is always defined to have:
 - People, Information, Tools/Machines, Materials, Time, Money, Energy
- Process covers the whole production cycle
- Output can include multiple products from the multiple inputs
- Feedback includes profit/loss, customer responses, and recyclables. Loop is open.

Engineering Design

A design challenge where students design a new appliance based on:

- The properties of the material
- The processing required

The design includes

- A proposal for materials
- A proposal for function and testing
- Instructions for usage and maintenance

MATERIALS:

- Engineering notebooks, instructions, graph paper, student instructions

PRE-PROJECT CLASS DISCUSSION:

The teacher will review engineering design, brainstorming and patent and trademark notes.

Students will get a short background lesson on the manufacture of chocolate, including the process used by the ChocoEasy® by Netzsche, a device which can create chocolate going from bean to bar. Their task is to create a device to use one of the intermediate products, chocolate baking powder found in most supermarkets, to create a sauce. They are told that it does not mix easily

Research Experiences for Teachers (RET) – 2014

with water or milk, because it creates a suspension, so an emulsifier must be added, along with a sweetener and flavorings. With this background they can design the mixer and heater.

CLASSROOM ACTIVITY DESCRIPTION

Students work in small groups to create design specification for a small table top or hand held device that mixes up and heats a set of not so easily mixed ingredients, cocoa powder, sugar, water or milk, flavorings and emulsifiers, and dispenses a warm chocolate sauce. Their design must include drawings, as close to scale as possible, of the various views of the device.

- 1) They will brainstorm ideas and record them in their engineering notebooks
- 2) They will annotate their design drawings to indicate how the device is powered and performs the required functions
- 3) They will include user instructions for safe and proper usage, care, and cleaning.
- 4) Students will use their drawing as a draft for a patent application, which includes an introductory paragraph or abstract, and a description of all the parts as indicated in the drawing. Students will have copies of “model patents” to use for style. They may also include other forms of intellectual property protection such as trademarks.

SAMPLE QUESTIONS TO ELICIT CLASS DISCUSSION:

The teacher will review engineering design, brainstorming and patent and trademark notes. What kinds of processes can both heat and mix a mixture? What are the types of patents? What is a trademark?

CLASSWORK/HOMEWORK:

Students complete work not done in class for homework. Depending on the ability of the class, students may use one to four days of class time plus homework time to complete the project and present their work in class. (based on a 40 minute class)

ASSESSMENT:

The concept for the lesson is tested two ways:

1. A simplified challenge: students only had to describe the device – drawing optional
 - Tested use of engineering design method
 - Individual responses
2. A detailed challenge: Student had to design the device with dimensions – drawing required
 - Engineering design in a team project
 - Proposal detailed up to prototyping

PARAMETERS TO EVALUATE STUDENT WORK PRODUCTS:

Do the drawings include all details required by the design? Are there enough “views” of the design to show all the requirements? Is there a power source? Does the design show how the device can be cleaned? Does it show the capacity of the device? Does it include indications for the user? Does it have a nice exterior design? Are ideas and preliminary designs recorded properly in the engineering notebooks?

RUBRIC TO EVALUATE STUDENT WORK PRODUCTS:

Do the drawings include all details required by the design? 30%
- Are there enough “views” of the design to show all the requirements?

Research Experiences for Teachers (RET) – 2014

- Are all the details of the device numbered for an explanation?
 - Does the student designate materials for each part?
(With a reason for each material, e.g. plastic for weight, stainless steel for strength)
 - Does it have an exterior design? (possible design patent?)
- Does the design include all the functional parts? 30%
- Does it show the capacity of the device?
 - Does it show how the user dispenses the chocolate?
 - Does the design show how the device can be cleaned?
(Does it come apart? Can it be flushed?)
 - Does the design show controls for mixing and heating? (temperature and speeds)
 - Is there a power source? (plug, batteries?)
- Does the design include directions for the user? (for usage, cleaning and safety) 20%
- Does it contain a test plan? (e.g. run mixer at two speeds and 3 temperatures)
- Are ideas and preliminary designs recorded properly in their engineering notebooks? 20%

REFERENCES AND BACKGROUND INFORMATION:

Engineering Design method notes

<http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml>

http://www.nasa.gov/audience/foreducators/plantgrowth/reference/Eng_Design_5-12.html

Patent and Trademark notes can be found at: www.uspto.gov and

<http://www.uspto.gov/kids/index.html>

Alternate database for searching patents: <http://www.freepatentsonline.com/>

Older, 1930-1950, easy to read patents on Caloric stove parts, that can be used as models

Gustav Klein: US2374438, US2373189, US1754110, US2420780, US2461902, US2498554

ChocoEasy notes:

http://www.chocoeasy.co.uk/the_sizes/index.html

Research Experiences for Teachers (RET) – 2014

Engineering Design and Patent

Team _____ Period _____ Date _____

Sometime in the future, you enter an engineering design contest. The prize is a scholarship. The challenge is to design a new kind of kitchen gadget that mixes up and dispenses a hot chocolate sauce that can be used for decorating desserts. Using the Engineering Design Method propose a design for your device. Then draft a patent application for your design.

Requirement and Specifications:

- The device must be able to sit on a countertop, or be handheld
- Have a compartment and mixer for ingredients, powdered baking chocolate, sugar, flavorings, water or milk, and emulsifiers. (powdered cocoa is insoluble)
- Have a way to heat the mixture to a range of desired temperatures without burning,
- Have a handy dispenser that can be positioned to place chocolate on various items
- Be easy to clean up and store.
- Have a decorative exterior for an attractive look when in use, or just on display
 - 1) Draw and label a picture
 - 2) Create a design specification with
 - a. A list of materials for all parts, and a reason for each choice
 - b. A plan for a power source
 - c. A description of the function, including its capacity
 - d. A quality control test plan
 - e. A description of the user instructions, including operation, cleaning and safety
 - 3) Now that your product is designed, show how you would include the design plan in a patent application. What other types of intellectual property, IP, protection would you include?

To hand in: 1 Drawing, that can be copied into the patent application, 2 design spec, 3 IP protection plan: a patent application, including design spec info, and description of other IP

Research Experiences for Teachers (RET) – 2014

LESSON PLAN 2

MODULE TOPIC: The Chemistry and manufacture of chocolate

OBJECTIVE(S):

Students will be able to:

- Map the industry system which produces raw chocolate, taking into account environmental and economic factors, and examine the raw material.

STANDARD(S) & INDICATOR(S):

NGSS: HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, environmental impacts.

MATERIALS:

- Engineering notebooks, instructions, notes on systems engineering, student handout, glossary

LIST OF HANDOUTS (attach original copies of each handout - teacher & student edition)

Handout with student instructions - teacher notes include grading rubric

CLASSROOM ACTIVITY DESCRIPTION (LABORATORY/EXERCISES/PROBLEMS) including detailed procedures:

Students learn about processes to make chocolate, from bean to bar and map an industry system. Students also reflect on the environmental impact of growing and processing cocoa.

SAMPLE QUESTIONS TO ELICIT CLASS DISCUSSION:

Chocolate comes from nature, the cacao plant. What is needed to plant, farm and harvest cacao? How is harvested cacao processed into raw chocolate?

HOMEWORK ACTIVITY/EXERCISES/PROBLEMS:

Prepare for lesson by reviewing systems notes and background on the chocolate industry

PARAMETERS TO EVALUATE STUDENT WORK PRODUCTS:

Teacher rubric

REFERENCES and BACKGROUND INFORMATION:

Systems Engineering notes

<http://www.finechocolateindustry.org/>

<http://www.icco.org/about-cocoa/chocolate-industry.html>

<http://www.sciencechannel.com/tv-shows/how-its-made/videos/food-and-drink.htm> (cocoa beans)

<http://teachers.egfi-k12.org/guilt-free-chocolate/>

Research Experiences for Teachers (RET) – 2014

ACKNOWLEDGEMENT

This material is based upon work supported by the National Science Foundation under Grant No. 1301071

Copyright © 2014 by the Center for Pre-College Programs, of the New Jersey Institute of Technology. All Rights Reserved.

This material is based upon work supported by the National Science Foundation under Grant No. 1301071

Copyright © 2014 by the Center for Pre-College Programs, of the New Jersey Institute of Technology. All Rights Reserved.

Supporting Program: Center for Pre-College Programs, at the New Jersey Institute of Technology
Contributors

Marie Aloia, Bayonne High School, NJ, Primary Author

Howard Kimmel, Levelle Burr-Alexander, John Carpinelli - Center for pre-College Programs, NJIT.

Dr. Mohamed Azad, Dr. B. Patel, Dr. Ecevit Bilgili, Dr. Rajesh Dave - C-SOPS, NJIT

Research Experiences for Teachers (RET) – 2014
Systems map for the Chocolate Industry

Name _____

Define the role of each factor in the input section

| | |
|--------------------|--|
| People | |
| Information | |
| Tools/ machines | |
| Materials | |
| Time | |
| Capital | |
| Energy | |

Describe Processing steps/events

Describe Output

Feedback loop elements/criteria

Research Experiences for Teachers (RET) – 2014
Systems map for the Chocolate Industry

Name _____

Define the role of each factor in the input section

| | |
|--------------------|--|
| People | Farmers to grow and harvest beans, buyers to purchase beans for processors, workers to create chocolate products, vendors, and consumers |
| Information | Agricultural knowledge, inventory, marketing, nutrition |
| Tools/ machines | Farming tools, trucks for shipping beans and processed materials, confectionary processing, packaging machines. |
| Materials | Plants, seeds, fertilizer and water, harvested beans, cocoa products, packaging |
| Time | For growing, harvesting, drying/fermenting, shipping, processing, shipping finished products |
| Capital | For investments, salaries for workers, fees, licenses, insurance, utilities, income |
| Energy | For fuel, for processing |

Describe Processing steps/events

- Cacao planted, plants nurtured and watered, beans harvested, dried, fermented, roasted, shipped to processors for tempering and conching, then sold as cocoa powder and cocoa butter or liquid to be processed further into chocolate candy, etc.

Describe Output

Roasted cocoa beans, then tempered, conched cocoa powder and cocoa butter, then confectionary products

Feedback loop elements/criteria

Profit and loss from sales, customer comments, byproducts for compost, seeds
Open