**Subject area/course**: Science/Biology

**Grade level/band**: 9-10

**Task source**: Stanford Center for Assessment, Learning, and Equity (SCALE); author: Susan Schultz

**Making Bread**

**TEACHER'S GUIDE**

1. **Task overview**:

In this task, students will work in teams to develop a new recipe for Milo Bread Company. Currently, Milo produces very good bread, as evidenced by its weekly sales. However, recent sales have dropped and the CEO of Milo wants to improve the recipe. Students are asked to adjust the recipe used for Milo’s current famous bread to produce a new, better tasting bread. Students will research all the ingredients involved in the bread making process and conduct a series of experiments to achieve the best tasting bread. They will make an oral presentation to the CEO and Board of Directors to share what they have learned. They will complete individual lab reports and reflection essays detailing their findings and their learning.

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

[CCSS.ELA-Literacy.RST.9-10.1](http://www.corestandards.org/ELA-Literacy/RST/9-10/1/) Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

[CCSS.ELA-Literacy.WHST.9-10.4](http://www.corestandards.org/ELA-Literacy/WHST/9-10/4/) Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

[CCSS.ELA-Literacy.WHST.9-10.5](http://www.corestandards.org/ELA-Literacy/WHST/9-10/5/) Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

CCSS.ELA-Literacy.WHST.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

**2. 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.

Communication in Many Forms: Use oral and written communication skills to learn, evaluate, and express ideas for a range of tasks, purposes, and audiences. Develop and strengthen writing as needed by planning, revising, editing, and rewriting while considering the audience.

Interpersonal Interaction and Collaboration: Develop a range of interpersonal skills, including the ability to work with others, to participate effectively in a range of conversations and collaborations.

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.

**3. Next Generation Science Standards**

HS-LS1-3. Feedback mechanisms maintain a living system’s internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system.

HS-LS1-3. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

HS-LS1-1. Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

HS-LS1-6,HS- LS2-3. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

HS-LS3-2. Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.

1. **Time/schedule requirements:**

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| --- | --- | --- |
| **Days** | **What Students Need To Do** | **Products** |
| Day 1 | Intro: Get familiar with the task requirements, expectations, and due dates |  |
| Day 1 | Part 1: Research how bread is made and the role of yeast in the bread-making process | Lab Report |
| Days 2-5 | Part 2: Class discussion of variables to ‘test’ |
| Part 3: Design experiment |
| Part 4: Conduct the experiment |
| Part 5: Analyze and interpret your findings |
| Part 6: Draw your conclusions & write references |
| Day 6 | Part 7: Prepare a draft report for the CEO of the company; get peer feedback on your draft; revise and complete final report for the CEO |
| Day 8 | Part 8: Group presentation | Oral presentation |
| Day 10 | Part 9: Reflect on learning | Essay |

1. **Materials/resources:**

Students will need:

* Copy of the basic bread recipe (included in handout)
* All the ingredients listed (enough for each group to make two loaves of bread—a control loaf and an experimental loaf)
* Baking equipment: measuring cups and spoons, mixing bowls and spoons/spatulas, a mixer, an oven, baking pans
* Other equipment, ingredients, or materials requested by students, if approved
* Copy of the lab criteria and oral presentation criteria

Helpful links (for you or the students):

* http://www.exploratorium.edu/cooking/bread/bread\_science.html
* http://www.exploratorium.edu/cooking/bread/links.html#science

1. **Prior knowledge:**

Students will already know:

* The basics of cellular respiration and fermentation.
* Cellular respiration in plants and animals involves chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.
* Organisms such as yeast feed on the sugars in the dough, which is then broken down in a series of chemical reactions and rearranged to form new molecules.
* Small changes in one part of a system can cause changes to other parts.

Students will already be able to:

* Make logical connections between evidence and scientific conclusions.

1. **Connection to curriculum:**

The unit could be a culminating activity when studying cellular respiration/fermentation, unicellular organisms, and/or the experimental method and design process.

1. **Teacher instructions:**

Below is a comprehensive list of *suggested* ways to facilitate, organize, and scaffold student work, based on pilot implementation conducted by SCALE in real classrooms. You will, of course, need to choose what ideas meet the needs of your students, their previous experience with open-ended projects, and practicalities of your classroom/school, and adapt them accordingly.

You’ll notice that throughout we have tried to provide students with opportunities to make choices and take the lead in decision-making to complete this task. In this same vein, we encourage the use of peer-review and revision.

Possible Engagement Activity (The Hook”)

You might begin by giving students a sense of the power of yeast with a common demonstration. You’ll need:

* + - * + 1 packet of yeast
        + 1 cup of warm water
        + 2 Tablespoons of sugar
        + A small, empty water bottle
        + A large size balloon

Stretch out the balloon by blowing it up a couple times, and then lay it aside. Pour the warm water into the water bottle. Add the sugar and yeast. Swirl it around a bit and attach the balloon to the mouth of the bottle. After several minutes/over the course of the period, students will see the balloon starting to expand and begin to stand upright.

Introduce the Task

* After the introductory activity, review the task description and respond to any student questions.
* Suggest students design a template to be used to collect information and record references at the time data is being collected.
* Tell students that personal reflections should be written in a journal/log throughout the project.

Review Expectations

* Review the due dates/task timeline.
* Review expectations for working together in a group: the roles students should take on and the norms for behavior (for more details, see “Student Support” section).
* Allow students time to look at the Lab Report Criteria and the Oral Presentation Criteria. Clarify and respond to student questions.
* Explain that, as students work in their groups, they will be responsible for gathering information and making their own decisions. As the teacher, you will provide help/resources only when everyone in the group agrees that they need help or if there is information they can’t find themselves.

Part 1: Introduction (Team Activity)

Research the role of yeast in bread making and examine a basic bread recipe.

* What are the key ingredients in the recipe?
* What is the role of the yeast in the bread making process?
* What are the essential steps (procedures) in the bread making process?
* What are the biological processes that enable yeast to make bread rise?
* Explain the relationship between fermentation and cellular respiration and great tasting bread.

*Individual Task:*Students will prepare an introduction to the lab report sharing what they have learned about fermentation and cellular respiration during the bread making process.

Part 2: Discussion (Whole Class Activity)

Lead a discussion in which the students think about the research they conducted and put forth ideas of variables they may test and how. Some possibilities include:

* Changing the type of sugar (white sugar, honey, Splenda, etc.);
* Changing the temperature/length of the proofing stage;
* Changing the amount/type of yeast (rapid rise, cake, etc.); or
* Changing the amount/type of liquid added.

Have the students agree on 2-4 different variables to test. Each group should select one of these tests to conduct so that at least 2 groups are conducting each test (i.e., at least 2 trials are conducted). Each group should make a “control” loaf and an “experimental” loaf.

Part 3: Design an experiment (Team Activity)

Using their knowledge about the factors affecting fermentation and cellular respiration and bread making, students will:

* Given the variable they are testing, explain how they think changing this variable will help make better tasting bread;
* Clearly identify all the variables to be studied (independent and dependent variables including controls, if applicable);
* Design a new bread recipe or process;
* Write a detailed recipe including the quantities and type of ingredients as well as the step-by-step bread making process they plan to conduct;
* Write a detailed description of what they will measure and how (e.g., weight of the bread, taste, texture, etc.);
* Provide a rationale for why they think their planned changes will make better bread. They should explain the connections between their proposed bread recipe, fermentation, and cellular respiration;
* Show their bread making procedures to you to check for any safety issues.

*Individual Task:*Each student will need to write the design of the experiment section in their lab report and they should refer to the Lab Criteria Sheet.

Part 4: Conduct experiment (Team Activity)

While conducting their experiment, students should take note of any changes they made to their procedure, record all relevant data, and indicate the number of trials performed during the experiment.

Part 5: Analyze and interpret findings (Team Activity)

This is an essential part of the investigation. Students need to carefully examine the data they have collected and determine what they can say about the results of the investigation based on the evidence.

*Individual Task:*Students should refer to the Lab Criteria Sheet when writing their individual analysis and interpretations of the data.

Part 6: Draw conclusions (Team Activity)

Students should review their analysis and interpretations of the data and write the conclusion section of the lab report. They should cite all of their references within the text and prepare a bibliography using the format you select (e.g., APA, MLA).

*Individual Task:*Students should refer to the Lab Criteria Sheet when writing the conclusion section of their lab reports.

Part 7: Submit draft lab report (Individual Activity)

Students will write a draft of their lab report. They should get teacher or peer feedback and then revise and submit the lab and all supporting materials.

Part 8: Present findings (Team Activity)

Students will make an oral presentation using a visual (PowerPoint or poster) to the Milo Bread Company CEO and Board of Directors. They should share the design and experimental findings of their investigation, including how they selected their independent and dependent variables. They will present their recommendations to the panel. When preparing their presentation, students should follow the criteria described in the Oral Presentation Criteria handout.

1. **Student support:**

Planning for Group Interaction

Grouping: Student grouping can vary, but group sizes of 3 or 4 for teams seemed to work well.

Roles:

It often helps group dynamics to assign students to specific roles (i.e., facilitator, researcher, presenter, recorder, etc.) in order to promote student learning and/or to utilize student skills.

* Facilitator – Timekeeper and task master (make sure group stays on task and that each assigned bullet is completed)
* Materials manager – Responsible for getting all materials, keeping track of them, and putting them away
* Recorder – Note taker and collects pertinent information from the researchers
* Presenter – Presents group information for each part

No matter what the team size, it is critical that each team keeps detailed records, and thus there must be at least one recorder for each team.

Suggested classroom norms to be used during the task:

* You have the right to ask for help and ask questions.
* You have a duty to assist others.
* Share your ideas with others.
* Make a plan.

1. **Extensions or variations:**

* There are many different types of bread, beyond the basic recipe provided, that you may want to use as the basic recipe. Students may make Amish Friendship bread which requires them to make a yeast starter (and feed for 10 days) and then the bread itself. (http://baking.about.com/od/friendshipbread/r/amishfriendshipbreaddirections.htm)
* The bread-making could be a homework assignment if you are certain students have access to ingredients and equipment.

1. **Scoring:**

This task can be scored using the SCALE Scientific Practices Rubric and the SCALE Effective Communication Oral Presentation Rubric.