5E STEM Unit Plan: Just Popping up

120 class hours / 3 blocks to complete the lesson.

Authors

Danielle Shaw-Jones

Andrew Berta

LaJoyce Sanders

SUBJECT/GRADE LEVEL

Subject Area: STEM

Grade Level: High School

Materials

- Access to electronic tool with access to wifi.
- Student copies of the following forms:
    - Site: Science Buddies https://www.sciencebuddies.org/science-fair-projects/science-fair/steps-of-the-scientific-method
    - Science fair Question
        - Finding an Idea for Your Science Fair Project:
        - Laboratory Notebook:
    - Research
        - Background Research Plan:
        - Finding Information

            Bibliography:

            Research Paper:
    - Construct a Hypothesis
        - Variables
        - Writing a hypothesis
        - Test the hypothesis
    - Analyze data and draw a conclusion
        - Data Analysis and Graphs
        - Conclusion
    - Communicate results
        - Final report
        - Abstract
        - Presentation
- Plan for a class of 15-20 students.
- Research notebook
- Writing utensil

STANDARDS

Next Generation Science Standards

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. *(HS-ETS1-1)*

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1)

Mathematics Standards | Common Core State Standards

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1)

MP.4 Model with mathematics. (HS-ETS1-1)

English Language Arts Standards | Common Core State

LESSON OBJECTIVE(S)

Students will be able to: (from NGSS)

2.2 Product Development: Develop an original idea for a new biotechnology product, and simulate a situation in which the product must be pitched to a prospective client. Create an informational packet to share during the presentation that includes the following items: definition and protection of intellectual property, type of patent, copyright issues and rules, trademarks, and breeders' rights for plants or animals.

2.3 Biotechnology in Society: Develop an argumentative essay surrounding public perceptions and attitudes toward the use of biotechnology in society. Develop claims and counterclaims thoroughly based on facts from research, pointing out the strengths and weaknesses of each claim. Document information using appropriate industry terminology.

CAREER CONNECTION(S)

Mentor Background: Benjamin Nye

-Dr. Benjamin D. Nye is the Director of Learning Sciences at USC-ICT. Ben's major research interest is to identify best-practices in advanced learning technology, particularly for frontiers such as distributed learning technologies (e.g., cloud-based, device-agnostic) and socially-situated learning (e.g., face-to-face mobile use).

- Ben's research tries to remove barriers to development and adoption of ITS so that they can reach larger numbers of learners, which has traditionally been a major roadblock for these highly-effective interventions. He also believes that the future of learning science depends on large, sustainable platforms with many users, where efficient sampling techniques can be used to drive new designs for experiments.

- Finally, he is interested in making the process of science more efficient, such as by advanced metadata and analysis for scholarly publications.

STEM Careers:

In his recent work as a Research Professor at the University of Memphis, Ben led work on the Shareable Knowledge Objects (SKO) framework integrating ITS services such as AutoTutor for the ONR ITS Grand Challenge, helped data mine effort a corpus of 250k human-to-human online tutoring dialogs (part of the ADL PAL initiative), collaborated on ONR's PAL3 tutoring architecture for supporting life-long learning, and is an advisor and book editor for the ARL Generalized Intelligent Framework for Tutoring (GIFT) advisory panel.

ENGAGEMENT

***Brief Description:**

We will be creating an innovative interactive classroom where students are actively participating in their learning process. Students will be investigating a topic that is a concern in their everyday life. The topic must be researchable within a three week period and must be able to be completed within a five mile radius of the school (We can not do research on an ocean, if we are inland).

Procedures:

Thoroughly describe the procedures for the activity, including time frame. Be sure to include background information of the content, teacher and student actions, opportunities for formative assessment, hyperlinks, and possible adaptations for individual learners and/or virtual options. We will be looking at real world examples of how the process worked in real time.

1. Bell Ringer
2. Introduction to the Scientific Method

- Explain the Steps: Introduce the steps of the scientific method: Observation, Question, Hypothesis, Experiment, Data Collection, Analysis, and Conclusion.

- Real-Life Example: Provide a simple, relatable example of the scientific method in action (e.g., figuring out why a plant isn't growing well).

3. Interactive Activities

- Observation and Questioning:
  - Activity: Present an intriguing phenomenon (e.g., a plant bending towards light).
  - Task: Ask students to make observations and generate questions about why this happens.
- Formulating Hypotheses:
  - Activity: Show a short video or demonstrate an experiment.
  - Task: Have students write down possible hypotheses to explain the phenomenon.
- Designing Experiments:
  - Activity: Provide different materials and scenarios.
  - Task: In small groups, students design simple experiments to test their hypotheses.

4. Hands-On Experiments

- Conduct Experiments:
  - Activity: Choose a simple, safe experiment (e.g., growing seeds under different light conditions).
  - Task: Students conduct the experiment, ensuring they follow scientific method steps.
- Data Collection:
  - Activity: Provide templates for recording data.
  - Task: Students observe and record their data methodically.
- Analysis and Conclusion:
  - Activity: Guide students through analyzing their data to identify patterns or results.
  - Task: Students draw conclusions based on their data and discuss whether their hypotheses were supported.

5. Real-world Applications

- Case Studies:
  - Activity: Present case studies of famous scientific discoveries (e.g., Newton's law of gravity).
  - Task: Students identify how the scientific method was applied in these cases.
- Guest Speakers:
  - Activity: Invite a scientist to talk about their work and how they use the scientific method.
  - Task: Students prepare questions to ask the speaker about their research process.

6. Engagement and Discussion

- Group Discussions:
  - Activity: Facilitate group discussions on various scientific questions or topics.
  - Task: Encourage students to use the scientific method to discuss and propose solutions.
- Debates:
  - Activity: Organize debates on scientific theories or discoveries.
  - Task: Students argue for or against a hypothesis using evidence and scientific reasoning.

7. Assessment and Reflection

- Quizzes and Tests:
    - Activity: Conduct quizzes to test understanding of the scientific method steps.
    - Task: Include questions that require students to apply the scientific method to new scenarios.
- Reflective Journals:
    - Activity: Have students keep a journal of their experiments and thoughts on the scientific method.
    - Task: Regularly review and reflect on their learning process and outcomes.

EXPLORATION

Brief Description:

The students will think about biotechnology's role in product development and society by watching a short video clip that highlights groundbreaking biotechnology products such as CRISP, a gene editing technology, which will be followed by a class discussion. The students will investigate and gather information about biotechnology development and public perceptions. The Biotechnologies areas they can research are: Agricultural Biotechnology, Environmental Biotechnology, Industrial Biotechnology, Medical Biotechnology, and Blue Biotechnology.

Procedures:

EXPLORE PART 1

Video Link Options:

1 - **"CRISPR: The Revolution in Gene Editing" by Kurzgesagt – In a Nutshell**

- Link to Video
- This animated video provides a clear and concise explanation of CRISPR technology, its potential applications, and the ethical considerations involved.
- Video Worksheet and Answer Key

2 - **"CRISPR-Cas9 and beyond: Jennifer Doudna**

- Link to Video
- In this TED Talk, Jennifer Doudna, one of the co-inventors of CRISPR, discusses the science behind gene editing and the future possibilities it holds.
- Video Worksheet to Option 2 with Answer Key

3 - **"How CRISPR lets you edit DNA by Andrea M. Henle**

- Link to Video
- This TED ED video is an animated video that models how CRISPR edits DNA to cure diseases.
- Video Worksheet to Option 3 with Answer Key

DISCUSSION Questions after the video:

- What is biotechnology?
- How can biotechnology impact our daily lives?
- What are some potential benefits and risks of biotechnology?

(MAX Time: 10 - 15 Minutes)

EXPLORE ACTIVITY PART 2

The students will be divided into small groups and each group will be assigned a different biotechnology branch to research. They must identify and report on a product from the biotechnology category they are assigned using poster size chart paper. They will need to understand the biotechnology category and its impacts on society. They will gather the following information on the product:

- The scientific principles behind the product
- The development process
- Potential applications and benefits
- Ethical and societal implications
- Share the following hyperlink with the students: Concept Map on Biotechnology
- Have the students use various resources (data, videos, multimedia) to research their assigned Biotechnology Area and identify a biotechnology product.
- Make sure to have the students focus on Key Points and societal impacts

(MAX: 30 minute)

Extension Activities

- Science Fair Projects:
  - Activity: Organize a science fair where students present projects that use the scientific method.
  - Task: Students design, conduct, and present their own experiments.
- Field Trips:
  - Activity: Arrange visits to science museums, research labs, or nature centers.
  - Task: Students observe real-world scientific research and relate it to the scientific method.

EXPLANATION

Brief Description: During the explain section, the students will share what they have learned and understand the core concepts of biotechnology product development and how society views these innovations. Then, students will work in teams to integrate and evaluate multiple sources of information in diverse formats and media to address a question or solve a problem related to biotechnology.

Procedures:

a. Place the students into small groups of 3, no more than 4, with the same Biotechnology. Have them discuss their research within the group, including a review of their biotechnology product. **(5 Minutes)**

b. Jigsaw Activity:

Form **new groups** with one member from each original Biotechnology group.

Each member must share their original group's findings.

Students should take notes and discuss the different perspectives of biotechnologies and their societal impacts

(Optional) Students should complete a PEER EVALUATION on the speaker using the JIGSAW RUBRIC. If peer reviews are used then review the rubric with the class before beginning the JigSaw Activity. Each presenter should receive 2 to 3 peer review feedback.

(10 to 15 Minutes)

JIGSAW RUBRIC - All criteria in the rubric do not have to be evaluated.

c. ***Intellectual Property*** Slideegg Presentation: https://www.slideegg.com/intellectual-property

(Note: This presentation can be downloaded for free and edited as needed)

THIS PART OF THE LESSON INCLUDES THE IMPORTANCE OF HOW TO PROTECT YOUR PRODUCT IDEA AND IS NECESSARY IN MEETING THE STANDARDS.

Guided Notes to Presentation (STUDENT COPY)

TEACHER COPY

ELABORATE

Brief Description:
Each group will develop a detailed proposal for their biotechnology product, including an informational packet on the intellectual property that needs legal protection from theft. They must prepare a pitch to present their product to prospective clients using their classmates acting as clients.

Procedures:
The structured approach to how this process is to be completed is linked below. It will guide your students in developing a comprehensive proposal and preparing persuasive pitches as well as how they can enhance their understanding of biotechnology product development and intellectual property protection. Please click on the Project Outline hyperlink below.

Project Outline

Rubrics - The rubric is designed to allow for flexibility in the evaluation of Product Proposal, Informational Packet on Intellectual Property, Pitch, and Teamwork.

EVALUATION

Brief Description: Evaluation will be complete with the assistance of a grading rubric and a team evaluation form.

Procedures

1. Assessment Rubric

For each criterion, define different levels of performance. Typically, rubrics use a scale (e.g., 1 to 4 or 1 to 5) with descriptors for each level. For example:

- Understanding of the Scientific Method:
    - 4 (Excellent): Thorough and accurate explanation of all steps.
    - 3 (Good): Clear explanation, with minor omissions.
    - 2 (Satisfactory): Basic explanation, but lacks detail.
    - 1 (Needs Improvement): Incomplete or inaccurate explanation.

Rubric

Criteria	4 (Excellent)	3 (Good)	2 (Satisfactory)	1 (Needs Improvement)	Weight (%)
Understanding of Scientific Method	Thorough explanation	Clear explanation with minor gaps	Basic explanation, lacks detail	Incomplete or inaccurate	20%
Research Question and Hypothesis	Clear, original, relevant	Clear, mostly original, relevant	Clear but somewhat vague or common	Unclear or irrelevant	15%
Methodology	Detailed, appropriate procedures	Generally good, minor issues	Adequate, but some flaws	Incomplete or inappropriate	15%
Data Collection and Analysis	Accurate, well-organized, insightful	Generally accurate and organized	Some errors, lacks organization	Inaccurate or poorly organized	20%
Conclusion	Strong logical connection	Mostly logical, minor issues	Basic, some gaps in logic	Weak or illogical conclusion	10%
Presentation Skills	Clear, engaging, well-organized	Clear and organized, less engaging	Some clarity and organization	Unclear, disorganized	10%
Engagement and Communication	Highly engaging and clear	Engaging and clear with minor issues	Some engagement, clarity issues	Lacks engagement or clarity	5%

References and Citations	Correct and complete	Mostly correct, minor errors	Some errors or incomplete	Incorrect or missing	5%

Using the Rubric

1. Distribute the Rubric: Give students the rubric ahead of time so they understand the expectations and can use it to guide their work.
2. Score Consistently: Use the rubric to score each presentation, ensuring that each criterion is assessed according to the same standards.
3. Provide Feedback: Use the rubric's notes section to provide specific feedback on strengths and areas for improvement.
4. Reflect and Adjust: After using the rubric, reflect on its effectiveness. Adjust the criteria or performance levels as needed based on student performance and feedback.

By clearly defining expectations and providing a structure, students understand what is expected of them. The teacher can grade more consistently and provide detailed, next step feedback.

2. Team/self Evaluation form:

Team Evaluation Form

REFERENCES

ChatGTP

EdrawMind
https://www.edrawmind.com

Magic School AI
https://app.magicschool.ai/tools