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

**Grade level/band**: 9-11

**Task source**: Summit Public Schools

**Bioremediation**

**TEACHER'S GUIDE**

1. **Task overview**:

In this task, students design an experiment using Fast Plants to test how well they remove copper and zinc toxins from the environment. There are 3 parts: 1) Preparation and participation in a Socratic Seminar on electronic waste (e waste), 2) Designing and conducting a multi-week experiment using Fast Plants and copper and zinc toxins, and 3) Analyzing and communicating the results from the experiment in a lab report.

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

CCSS.ELA-LITERACY.SL.9-10.1.A Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

[CCSS.ELA-Literacy.RST.11-12.9](http://www.corestandards.org/ELA-Literacy/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.

[CCSS.ELA-Literacy.WHST.11-12.1.a](http://www.corestandards.org/ELA-Literacy/WHST/11-12/1/a/) Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

[CCSS.ELA-Literacy.WHST.11-12.5](http://www.corestandards.org/ELA-Literacy/WHST/11-12/5/) 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.11-12.1.e](http://www.corestandards.org/ELA-Literacy/WHST/11-12/1/e/) Provide a concluding statement or section that follows from or supports the argument presented.

[CCSS.ELA-Literacy.WHST.11-12.7](http://www.corestandards.org/ELA-Literacy/WHST/11-12/7/) 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.

1. **Critical Abilities**

Research: Conduct sustained research projects to answer a question (including a self-generated question) or solve a problem, narrow or broaden the inquiry when appropriate, and demonstrate understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, use advanced searches effectively, and assess the strengths and limitations of each source in terms of the specific task, purpose, and audience.

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.

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.

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.

1. **Other standards**

*Next Generation Science Standards*

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

1. **Time/schedule requirements:**
* Step 1: Graphic Organizer: Socratic Seminar Prep and Step 2: Socratic Seminar: E-Waste: approximately 2 weeks
* Step 3: Brainstorm: Experiment Design; one week
* Step 4: Lab Report: Research Question & Hypothesis: one week
* Step 5: Plant Fast Plants: one week
* Step 6: Lab Report: Procedure: one week
* Step 7: Add Toxins to Fast Plants: one week
* Step 8: Lab Report: Data Table: two weeks
* Step 9: Take Final Measurements of Fast Plants: one week
* Step 10: Lab Report: Analysis: one week
* Step 11: Lab Report: Conclusion: one week
* Step 12: Project Checklist and Peer Review: one week
* Step 13: Submit Project
1. **Materials/resources:**

Documents:

* Item A. Socratic Seminar E-Waste
* Item B. Graphic Organizer – Socratic Seminar
* Item C. Background Info and Experiment Brainstorm
* Item D. Research Question Hypothesis
* Item E. How to Write a Procedure
* Item F. Lab Report Analysis
* Item G. Lab Report Conclusion
* Item H. Lab Report Outline

Suggested readings (texts and videos) include:

Videos

* E-waste Hell (Ghana): <https://www.youtube.com/watch?v=dd_ZttK3PuM>
* Story of Stuff: Electronics: <http://storyofstuff.org/movies/story-of-electronics/>
* 60 Minutes: Electronic Wasteland: <https://www.youtube.com/watch?v=SCGEvOmKo98>
* Citizens at Risk (India): <https://www.youtube.com/watch?v=jkndVAwBf_k#t=97>

Texts

* E-waste Problem Overview: <http://www.electronicstakeback.com/resources/problem-overview/>
* Body Burden Diagram: <http://svtc.live2.radicaldesigns.org/wp-content/uploads/Body-Burden-pdf>
* E-Waste Dumping Map: <https://infrarati.files.wordpress.com/2010/08/ewastemap2.jpg>
* E-waste In Landfills: <http://www.electronicstakeback.com/designed-for-the-dump/e-waste-in-landfills/>
* Cell Phone Recycling: <http://www.eoearth.org/view/article/150977/>
* E-waste Recycling in Prisons: <http://www.electronicstakeback.com/global-e-waste-dumping/prison-recycling/>
* Facts & Figures on E-waste Recycling: <http://www.electronicstakeback.com/wp-content/uploads/Facts_and_Figures_on_EWaste_and_Recycling.pdf>
* State Legislation-E-Waste: <http://www.electronicstakeback.com/promote-good-laws/state-legislation/>
* Toxic Sweatshops (E-waste Recycling in Prisons): <http://www.electronicstakeback.com/wp-content/uploads/ToxicSweatshops1.pdf>
* Exporting Harm (The High-Tech Trashing of Asia): <http://svtc.org/wp-content/uploads/technotrash.pdf>
* The Digital Dump (Exporting Re-use and Abuse to Africa): <http://svtc.org/wp-content/uploads/TheDigitalDump.pdf>
* More Reports by Silicon Valley Toxics Coalition: <http://svtc.org/resources/reports/>
1. **Prior knowledge:**

None provided.

1. **Connection to curriculum:**

None provided.

1. **Teacher instructions:**

Step 1: Graphic Organizer: Socratic Seminar Prep: Have students watch and read provided resources to prepare for Socratic Seminar. Have students complete the Graphic Organizer to provide evidence for discussion.

* Item A. Socratic Seminar E-Waste
* Item B. Graphic Organizer – Socratic Seminar

Step 2: Socratic Seminar: E-Waste

Step 3: Brainstorm: Experiment Design: Have students read background information and answer reflection questions for each section. Students should read and summarize two Bioremediation case studies of their choice. Students should complete the chemical case study jigsaw and get to know fast plants group activities. Have students answer the provided questions as a group to brainstorm about experimental design.

* Item C. Background Info and Experiment Brainstorm

Step 4: Lab Report: Research Question & Hypothesis: Using the research question hypothesis organizer, have students identify their team’s Bioremediation experimental variables (dependent and independent), formulate a hypothesis and finalize their Bioremediation experimental design.

* Item D. Research Question Hypothesis

Step 5: Plant Fast Plants

Step 6: Lab Report: Procedure: Have students complete multiple write a procedure activities to develop the skills needed to describe their research methods.

* Item E. How to Write a Procedure

Step 7: Add Toxins to Fast Plants

Step 8: Lab Report: Data Table

Step 9: Take Final Measurements of Fast Plants

Step 10: Lab Report: Analysis: Have students answer the guiding questions in the provided analysis graphic organizer to complete their data analysis paragraphs.

* Item F. Lab Report Analysis

Step 11: Lab Report: Conclusion: Have students answer the guiding questions in the provided report conclusion graphic organizer to complete their reports.

* Item G. Lab Report Conclusion

Step 12: Project Checklist and Peer Review

Step 13: Submit Project

1. **Student support:**
* To encourage collaboration, allow students to work in groups and provide time/materials for peer review of final materials before submission.
* Students should be provided access to guiding charts/tables and sentence completion exercises to help them organize information.
* If needed, provide students with additional time to preform initial background research and prepare lab report.
* Multiple levels of reading material as well as videos are provided for student research.
1. **Extensions or variations:**

None provided.

1. **Scoring:**

Student work can be scored using the Summit Public Schools Bioremediation rubric.