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

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

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

**Medical Mysteries**

**TEACHER'S GUIDE**

1. **Task overview**:

In this task, students are asked to construct an argument about the probable cause of death of a fictitious young man who collapsed and died at a local university. Students are given a set of information and will be continuously supplied with new information and the results of lab tests throughout the task. Students will need to consider all of the information carefully, will need to use their previous knowledge about disease and its impact on the body systems. They will need to use good deductive reasoning in order to determine why the healthy young man died. Students will prepare a medical case study report where they will need to summarize the facts of the case, research possible causes of death, examine resources (autopsy report and lab results), construct and justify an argument about the probable cause of death, and discuss the limitations of their argument.

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

[CCSS.ELA-Literacy.WHST.9-10.1a](http://www.corestandards.org/ELA-Literacy/WHST/9-10/1/a/) Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

[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](http://www.corestandards.org/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.

[CCSS.ELA-Literacy.WHST.9-10.8](http://www.corestandards.org/ELA-Literacy/WHST/9-10/8/) Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

[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.RST.9-10.4](http://www.corestandards.org/ELA-Literacy/RST/9-10/4/) Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.

[CCSS.ELA-Literacy.RST.9-10.7](http://www.corestandards.org/ELA-Literacy/RST/9-10/7/) Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

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.

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. **Next Generation Science Standards**
* 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-LS1-6),(HS-LS2-3)
* Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)
* Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)
* Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)
* Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS- LS4-2),(HS-LS4-4),(HS-LS4-5)
1. **Time/schedule requirements:**

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| --- | --- | --- |
| **Day** | **What Students Need To Do** | **Product** |
| Day 1 | Get familiar with the task requirements and expectations |  |
| Day 1 | Part 1: Review the information provided and brainstorm the possible causes of the patient’s death | Medical Case Study Report |
| Days 2 - 6 | Part 2: Research one potential cause of death based on the patient’s symptoms and identify what additional information you would need to make an accurate diagnosis  |
| Part 3: Review and analyze the patient’s autopsy results and re-evaluate the possible causes of death |
| Part 4: Conduct in-depth research of one other possible cause of death based on the autopsy report  |
| Part 5: Construct and justify your argument on the probable cause of death |
| Days 7 - 9 | Parts 6 & 7: Prepare draft of medical case study report and get peer feedback  |
| Day 10 | Part 8: Prepare final medical case study report  |
| Days 11-13 | Part 9: Group Presentation  | Oral Presentation  |
| Day 14 | Part 10: Reflect on Learning | Essay |

1. **Materials/resources:**

 Students will need:

* Access to the Internet for research
* Copies of the *Criteria for Oral Presentations* document
* Copies of the accompanying resource cards, as needed/requested (attached):
	+ Inspiration Daily News article
	+ Resource Card 1: The victim’s autopsy
	+ Resource Card 2: Graphic organizer
	+ Resource Card 3: Lab test results
* Presentation software or poster-making materials for the presentation
1. **Prior knowledge:**

Students should already know:

* The difference between bacteria, viruses, and protozoa
* Each of the body systems and how these systems interact with one another
1. **Connection to curriculum:**

This unit could be a culminating activity after studying all the body systems in a regular biology course, for a unit on anatomy/physiology, or on scientific ways of knowing.

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 which 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 the task. In this same vein, we encourage the use of peer-review and revision.

Mention that disease does affect all people and does cause death. Help students understand that death is a tough emotion for us all. Maybe have a short discussion to let students reflect on disease and death in their own lived experiences. This may help some students who have had family members die understand that it is close to many students’ hearts. Also, let students know that if they need to talk to anyone, they may come see you.

Engagement Activity (The Hook)

Have students read the Inspiration Daily News article. Ask the class to brainstorm some possible causes of death. They may generate a list similar to the one below. Have them suggest what they would need to know to determine if the student’s death was a result of:

* food poisoning or food allergies
* heart attack or heart defects
* stroke
* diabetes
* bacterial infection
* viral infection
* parasites
* environment (mold or fungus)
* other brainstormed ideas

Introduce the Task

* After the introductory activity, read aloud the task description on page one. Go over the logistics and deadlines.
* Read each bullet aloud and ask if students need any clarification.
* Suggest a template 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 for each part of the task.

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 rubric(s), clarify the oral presentation criteria, and respond to student questions.
* Explain that, as they work in their groups, students 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: Brainstorm the possible causes of Samuel Harris’ death (Team Activity)

Students should review the newspaper article about Samuel Harris’ death and generate what they think are the most probable causes of his death. They should provide evidence from the newspaper article to support each possible cause of death and should discuss what information they would need to confirm or reject a diagnosis.

Part 2: Become an expert on one potential cause of death (Team Activity)

Students will research one potential cause of death that matches the victim’s symptoms. Collect information from a variety of Internet sources and discuss any potential bias within the documents. Their research should:

* Describe the potential cause of death and provide a visual of the body system or portion of the body that would be impacted.
* Summarize the evidence that they have gathered.
* Based on the evidence, reflect on whether they have enough information to make a diagnosis.
* Determine what additional information they need to know before confirming or ruling out the possible cause of the victim’s death.

Students should use the research information and discussion with group members to write an introduction to their individual Medical Case Study on the potential cause of death.

Part 3: Review and analyze the autopsy (Team Activity)

Based on their analysis of the autopsy (see Resource Card 1), students should evaluate the feasibility of their original diagnosis. They should:

* Describe and explain any patterns and/or trends that they noticed when examining the autopsy report.
* Explain whether their team will continue with the original diagnosis or change the diagnosis based on the autopsy results.
* Use evidence from the autopsy report to reject any possible cause of death.
* Identify the most feasible cause or causes of death citing evidence from the autopsy report.
	+ Summarize what they learned from the autopsy report and reflect on how that influenced their current diagnosis.

Students should record this information in their journals.

Notes to Teacher

After students review the autopsy report they will have evidence that Samuel Harris had meningoencephalitis. We have provided a definition and some additional resources for students to start their research on the various causes of this disease.

*Meningoencephalitis* is a [medical condition](http://en.wikipedia.org/wiki/Disease) that simultaneously resembles both [meningitis](http://en.wikipedia.org/wiki/Meningitis) which is an [infection](http://en.wikipedia.org/wiki/Infection) or [inflammation](http://en.wikipedia.org/wiki/Inflammation) of the membranes and [encephalitis](http://en.wikipedia.org/wiki/Encephalitis), which is an infection or inflammation of the [brain](http://en.wikipedia.org/wiki/Brain).

 *meninges* = membranes

 *encephala* = brain

 *itis*= infection or inflammation

Potential Causes of Meningoencephalitis **–** the students will need to research these different causes of meningoencephalitis to see which one might be associated with Samuel Harris’s death.

 Bacterial

* *Coxiella burnetti*
* *Listeria monocytogenes*

 Viral

* [*Tick-borne meningoencephalitis*](http://en.wikipedia.org/wiki/Tick-borne_meningoencephalitis)
* [*West Nile virus*](http://en.wikipedia.org/wiki/West_Nile_virus)

 Protozoal

* [*Primary amoebic meningoencephalitis*](http://en.wikipedia.org/wiki/Primary_amoebic_meningoencephalitis)
* [*Toxoplasma gondii*](http://en.wikipedia.org/wiki/Toxoplasma_gondii)

Part 4: Conduct an in-depth study of an *alternative* cause of Samuel Harris’ death (Team Activity)

Working in groups, students research everything there is to know about the cause of death that the team thinks is most likely now that they have seen the autopsy report. Students should:

* Identify the key information that will help them to either reject or confirm a claim about the potential cause of death.
* Test the reliability of their sources by verifying information from multiple sources and cite the source of all their information.
* Students can view the lab tests done on the patient to obtain additional information (see the resource materials attached to this document, specifically Resource Card 3). Remind students that lab tests cost money so they need to provide an explanation of what they will be able to conclude based on the lab test results.
* Compare all of the lab tests for the victim with the range of normal or acceptable values that they gathered during their investigation.
	+ Organize the data into charts, tables, and/or graphs where appropriate. Remember to properly label everything and provide a key/legend when applicable.
	+ Summarize what they learned from each lab result and reflect how that influenced their current diagnosis.

Students should record this information in their journals.

Part 5: Construct an Argument with Evidence (Individual Activity)

* Students should review their analysis and interpretations and construct an argument with a claim about the probable cause of death and the supporting evidence.
* Identify and explain other possible causes (counterclaims) of the victim’s death and explain whether it is supported and/or refuted by the data.
* Potential limitations of their argument based on the investigation (applications, medical decisions, personal decisions, etc.).
* Any new questions or unanswered questions that were generated during this study that they would like to explore in future investigations.

Students should record this information in their journal.

If your students have not had a lot of experience constructing arguments you might want to provide them with some sentence starters such as:

1. I think \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ was the probable cause of Samuel’s death because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. I have many sources of evidence that supports my claim. One pieces of evidence is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Another source of evidence is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
3. Others might think that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ caused Samuel’s death because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ but I disagree because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. I think my claim is the strongest because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
5. Although I have strong evidence to support my claim, there are limitations that may affect the accuracy of my claim such as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
6. I would want further information or tests such as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to be more confident in my claim.

Part 6: Draft medical case study report (Individual Activity)

Students will combine all of the research and test results they have gathered to write a Medical Case Study.

Part 7: Exchange draft Medical Case Study reports and get peer feedback (Pair Activity)

Part 8: Revise and finalize the Medical Case Study report

Part 9: Present findings (Team Activity)

Students will make an oral presentation to share what they learned about the cause of death of Samuel Harris. When preparing their presentation they should refer to the *Criteria for Oral Presentations* document.

Part 10: Reflect on their learning (Individual Activity)

Students write an essay reflecting on their learning over the course of completing this performance assessment, specifically explaining what they:

* Learned about the possible causes of death of the young man.
* Discovered about gathering facts, reviewing symptoms, determining possible causes of death, deciding on the appropriate lab tests to conduct, analyzing lab test results, making a diagnosis, and the impact on the human body.
* Used as strategies for learning, thinking, and producing work that were effective and those that did not work so well.
* Learned about investigative skills and/or their understanding of scientific inquiry.
* Contributed to their group work, the strengths of their team, and how the interactions within their group could be improved in the future.
1. **Student support:**

Planning for Group Interaction

Grouping: Student grouping can vary, but a group size of 3 or 4 seems to work well with this task. 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.

Introduction of Cooperative Learning

* Review with students the 21st Century Skills related to cooperative learning.
* Another option would be to discuss traits (including team work) that employers value in their workers.
* Group norms should be created prior to student collaboration. These can be given by the teacher or determined by the students. Or teachers can give norms for the first part(s) of the task and students can determine their own group norms for subsequent sections of the task. Sample norms include:
	+ - 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
* Students should realize that they will rely on the information gathered by members of their team on different parts of this task. Successful group work is critical to the successful completion of the task.
* Groups can be selected in many different ways. Random groups may be assigned (e.g., use of playing cards as students enter the classroom) or by seating assignments. Groups can be a heterogeneous mix of learning styles, reading levels, achievement, student interest, comfort level with technology, etc.
* Students can be assigned particular roles in their groups. Examples include timekeeper, facilitator, equipment manager, spokesperson, technology guru, recorder, etc. Role assignment can be random (e.g., the person facing west is the facilitator) or assigned based on student strength or area of practice for improvement.
* Roles can be discussed/brainstormed with students before group work begins. Student roles can also be explained on role cards, which are then given to students. Word stems or example statements for each role (Facilitator – “I appreciate what you have said about…”) can help students maintain their roles as they work together.

Variations and support for students with special needs or English language learners

* Provide students with multiple ways (written, verbal, and pictorial) to access the instructions so they know what to do.
* You may need to demonstrate some procedures and/or explain how various tests are performed.
* When researching and becoming an expert on one potential cause of death, provide students with a graphic organizer to keep track of their resources and findings effectively.
* Students could keep a glossary page in their scientific notebook to keep track of the new vocabulary they are using, as well as terms from previous lessons that they need to know for this task.
* Provide additional scaffolding to help students write their arguments (claim, evidence, counterclaims, justification, and limitations).
1. **Extensions or variations:**

You might jigsaw the activity by breaking students into “expert” groups. Each group becomes an expert on a specific cause of death and they then return to their “home group” to share information with others.

1. **Scoring:**

Student work can be scored using the SCALE Scientific Literacy Rubric and the SCALE Effective Communication Oral Presentation Rubric.