Science Assessment System Through Course Task

Chemical Spill

Grade Level:
7

Phenomena:
Contamination of a Stream

Science & Engineering Practices:
Analyzing and Interpreting Data
Engaging in Argument from Evidence

Crosscutting Concepts:
Patterns; Energy and Matter

Designed and revised by Kentucky Department of Education staff
in collaboration with teachers from Kentucky schools and districts.

Preparing to implement Through Course Tasks in the Classroom

What is a TCT?

- TCTs are 3-dimensional tasks specifically designed to get evidence of student competency in two dimensions, Science and Engineering Processes (SEPs) and Crosscutting Concepts (CCC), untethered from Performance Expectations (PEs)/standards. Tasks are sense-making experiences.
- Tasks are to be used formatively. The goal is for both students and teachers to understand areas of strength and improvement for the SEP(s) and CCC assessed within the task.

How do I facilitate a Through Course Task (TCT)?

- TCT facilitation is a collaborative process in which teacher teams calibrate understanding of the expectations of the task and refine strategies to be used during task facilitation.

Before the task:

1. Complete the TCT as a learner – compare understanding of task through the lens of success criteria (identified in the task) in order to understand expectations.
   Success criteria include:
   - What is this task designed to get evidence of?
   - What is the task asking the students to do?
   - What might a student response look like?
2. Identify the phenomenon within the task. Consult resources to assure teacher teams have a deep understanding of associated science concepts.
3. Collaborate to generate, review and refine feedback questions during facilitation.
4. Identify potential "trouble spots" and plan for possible misconceptions.

During the task:

5. Collect defensible evidence of each student's competencies in 3-dimensional sense-making for the task.
6. Ask appropriate feedback questions to support student access and engagement with the task in order to elicit accurate evidence of student capacities.

After the task:

7. Reflect on the task as a collaborative team.
8. Review student work samples to identify areas of strength and areas of need.
9. Determine/plan next steps to move 3-D sense making forward through the strengthening of the use of SEPs and CCCs.

Using the materials included in this packet:

- **Task Annotation:**
  - The task annotation is a teacher guide for using the task in the classroom. Additionally, the annotation gives insight into the thinking of developers and the task overall.

    - Each task has science and engineering practices, disciplinary core ideas, and crosscutting concepts designated with both color and text style:
        - **Science and Engineering Practices**
        - *Disciplinary Core Ideas*
        - Crosscutting Concepts
- **Student Task:** The materials to be used by students to complete the TCT.

Chemical Spill Task Annotation

After analyzing and interpreting data related to the characteristic properties, chemical reactions and the evidence surrounding a chemical contamination of a stream, **develop an argument** for the *source of the contamination* supported by patterns in the data and the conservation of mass as evidence to **support the reasoning for you argument**.

Overall intent

This task was developed with the intention of evaluating students' ability to analyze and interpret data about a phenomenon and explain the phenomenon by creating an argument that is based on the evidence they collected. This task is intended for 7th grade.

This task is intended to assess a student's ability to analyze and interpret data (textual, visual, and quantitative) in order to draw out key evidence or patterns that can be used to explain a phenomenon. Furthermore, this provides an opportunity for the student to use their organized data to engage in an argument to explain a phenomenon.

Phenomenon within the task

The phenomenon is the unknown source of contamination of a stream. There are two possible sources: a chemical spill from a truck, and animal waste from a nearby farm. Investigation into the most probable source is reasoned using the conservation of mass and patterns in available data. The context for this task presents an accident on a highway that is located between farmland and an industrial factory. The truck involved in the accident was carrying chemicals that are delivered to schools in Kentucky by a company called CHEM Supply Incorporated. During the accident, chemicals from the truck were spilled out onto the road. Weeks after the crash, there are reports of algae and high levels of phosphorus in the creek water that was next to the crash site.

Data and Background Support to Facilitate Phenomenon Development for Students

The evidence provided is:

1. A map of the scene that shows the proximity of the creek, the crash site and the factory.
    a. This allows the students to infer that the factory could be the source of the contamination.
2. The accident report that gives the date and summary of the accident.
    a. This provides background information such as time and description of location.

3. The complaint filed by the creek owner states that his pigs will not drink their primary source of water. In addition, there is algae and dead fish floating in the water.
    a. This provides evidence that details the issues revolving around this contamination and the date shows that they did not come up until after the date of the crash and chemical spill.
4. The lab report that gives the characteristic properties and amount of phosphorus that was found in the creek.
    a. This is used to compare to the chemicals in the truck and show that there was not phosphorus in the truck. This will assess if students understand that when two substances do not have the same characteristic properties, they are not the same substance.
5. The lab report that gives the characteristic properties and amount of all 10 chemicals that were in the supply truck.
    a. This is used to compare to the chemical in the creek and show that there was not phosphorus in the truck because the characteristic properties of the phosphorus in the creek match this report.
6. A lab report that will show that two of the chemicals in the truck (known by comparing the characteristic properties) interacted in a chemical reaction that formed phosphorus.
    a. This will allow the students to see that the amount of phosphorus formed through the chemical reaction was not enough to contaminate the creek. The mass of the amount formed is much less than what was found in the creek.
    b. This will see if the students know that a chemical reaction occurs when two substances interact and form a new substance, and that matter is neither created nor destroyed.
7. Research that will give alternate sources of phosphorus contamination.
    a. Students can come to the conclusion that the pig manure is what caused all of the issues reported.

Ideas for setting up the task with students

The background information for this phenomenon can be presented to students in the form of a news report. This will help inform students while also put them in the mindset of beginning to question the causes of a given phenomenon. Students can be offered a graphic organizer to help them organize their claim, evidence, and scientific reasoning. Some students may require additional explanation or clarification of the background information before beginning. All students were provided with a rubric for an argumentation writing piece. Students should understand that characteristic properties are used to identify substances because each substance has its own unique set of characteristic properties. Characteristic
properties are based on the structure of the matter at the atomic level. Two molecules with different atoms will have different characteristic properties. Students should be able to explain that a chemical reaction occurs when two or more substances interact

and form a new substance. This information can be supported by explaining that a new substance is able to be identified as new based on its having at least one different characteristic property from the reactants.

Intent of the Task for Assessment

The intent of this task is to elicit evidence about a student's ability to analyze and interpret data about a phenomenon based, in part, on patterns identified in a collection of data. Although students are asked to create a data table that organizes their interpretation of the evidence, this display is not the focus of evaluation of student success with the task. The purpose of creating the table is to increase the likelihood of authentic engagement with the data. The purpose is also to help the student better create their argument to explain the phenomenon. Students need to authentically consider how the phosphorus came to be in the creek. This leads students to genuine wonderings about how and why the phenomenon has occurred, which will hopefully result in accurate evidence of the student's ability to create an argument and provide a clear explanation of their reasoning. If students authentically wonder based on careful synthesis of data, connecting to whatever current knowledge they have about the phenomenon, or ways to solve problems, then the explanations, connections, and evidence offered by students based on their synthesis of data will be the best evidence of their ability to create an argument based on evidence.

List of components or the task/resources used within the task

- Exhibits A-G
- Task Rubric
- Graphic Organizer (optional)

Success Criteria

Evidence of Learning Desired based on Progression from Appendices

- Students analyze and interpret data to provide evidence for a phenomenon. (App F -- data)
- Students develop an argument supported by empirical evidence and scientific reasoning to support or refute an explanation for a phenomenon. (App F -- argumentation)
- Students recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure (using characteristic properties to identify and compare pure substances). (App G -- patterns)

- Students use patterns to identify cause and effect relationships.
- (App G -- patterns)
- Students explain that matter is conserved because atoms are conserved in physical and chemical processes. (App G -- Energy and Matter)

Success Criteria

1. Student makes a valid claim.
2. Student provides at least 3 pieces of relevant evidence to support their claim.
3. Student makes connections to the law of conservation of mass and chemical/physical properties to provide reasoning for their evidence.
4. Students use evidence to clearly explain that the pig manure was the contamination source.

Possible Student Responses

1. The evidence presented shows that CHEM Supply Company is not guilty of contaminating the creek; there are outside sources that are more likely to have caused contamination, the chemicals in the creek did not match the chemicals from the truck, and the amount of chemicals in the creek is more than the CHEM truck could have produced.
2. According to a lab report that shows what was found in the creek running through the Critter Craze, this creek was tainted by the chemical phosphorus. Secondly, chemical samples taken from the creeks matched no samples from the truck, making it impossible for the truck to contaminate the rivers. The two substances reacting together make a mass of 50 grams, therefore, they could not have even contributed to the 40,472 grams contaminating the creek.
3. The Law of Conservation of Matter tells us that no atoms can be taken or added in a chemical reaction. A lab report shows that the phosphorus found polluting the creek had a density of 1.82 g/mL. This is one characteristic property of phosphorus. A characteristic property is a trait of a chemical that is specific to that certain chemical. So, if only one characteristic property is different, the two chemicals being compared are not the same substance.
4. In conclusion, the phosphorus contamination in the creek is most likely from too much swine manure in the creek, not the CHEM Supply truck chemicals.

Other information teacher teams might find useful when preparing to use this task in the TCT process.

- Teachers should consider giving students a graphic organizer to help them organize their claim, evidence and scientific reasoning.

- Allow students to look at each exhibit one at a time to make observations and ask questions before moving on to the next one. This will help with the amount of information given.
- Allow students to collaborate during the exhibit observation and questioning process.

Extensions and/or other uses after the task is implemented

This task was designed for the specific purpose of evaluating students' abilities to create an argument based on evidence that they gathered by analyzing patterns in data. However, use of the task does not have to end with that outcome, and can provide opportunities for rich learning experiences without significant effort from the teacher. For example, after implementation of the task using the TCT process, a teacher might use the results of the task in other ways, including:

1. Students organize their data as a class to see patterns in their collected evidence.
2. Students critique the reasoning for using that evidence in an argument.
3. Students critique the claims they made in their arguments based on evidence.
4. Students create visual presentations to support their argument.
5. Students create a mock trial to present a team created argument. They compare and evaluate the individual arguments compared to the team.

Through Course Task – Chemical Spill

After analyzing and interpreting data related to the characteristic properties, chemical reactions, and the evidence surrounding a chemical contamination of a stream, develop an argument for the source of the contamination supported by patterns in the data and the conservation of mass as evidence to support the reasoning for you argument.

PART A: Analyze and Interpret the Data: **Analyze and interpret data to provide evidence for phenomena.**

State of Kentucky v. CHEM Supply Incorporated

Kentucky Court of Justice

FACTS: CHEM Supply Company, Inc is a chemical supply company that produces and delivers chemical supplies to businesses, colleges, and schools around the state of Kentucky. The CHEM Supply Company has met all legal requirements for environmental safety for their production and delivery to date. There have been no reports of environmental contamination, unlawful waste removal, or mishandling of products against this company.

ISSUE: One of the trucks delivering company supplies to Woodford County Public Schools was involved in an accident on the highway. City officials collected evidence at the scene of the accident to ensure that all chemicals were identified and logged as present at the scene. In the weeks that passed, several members of the community complained of unusual chemicals appearing in the water supply that surrounds the scene of the accident. The State has charged CHEM Supply Company with environmental endangerment. The company claims that the chemicals in the environment were not from their truck.

You are a forensic scientist that has been hired in order to help shed some light on the current situation. In order to explain how the creeks came to be contaminated, you will need to **review all of the evidence** carefully. **Organize the data into a table that you will use as your primary source of evidence for the argument you will create to explain the situation.** You may organize the data however you like, but you should remember that the purpose is to have your three main pieces of evidence clearly laid out for your argument, while also having other supporting evidence.

EVIDENCE

Exhibit A: Map of Scene

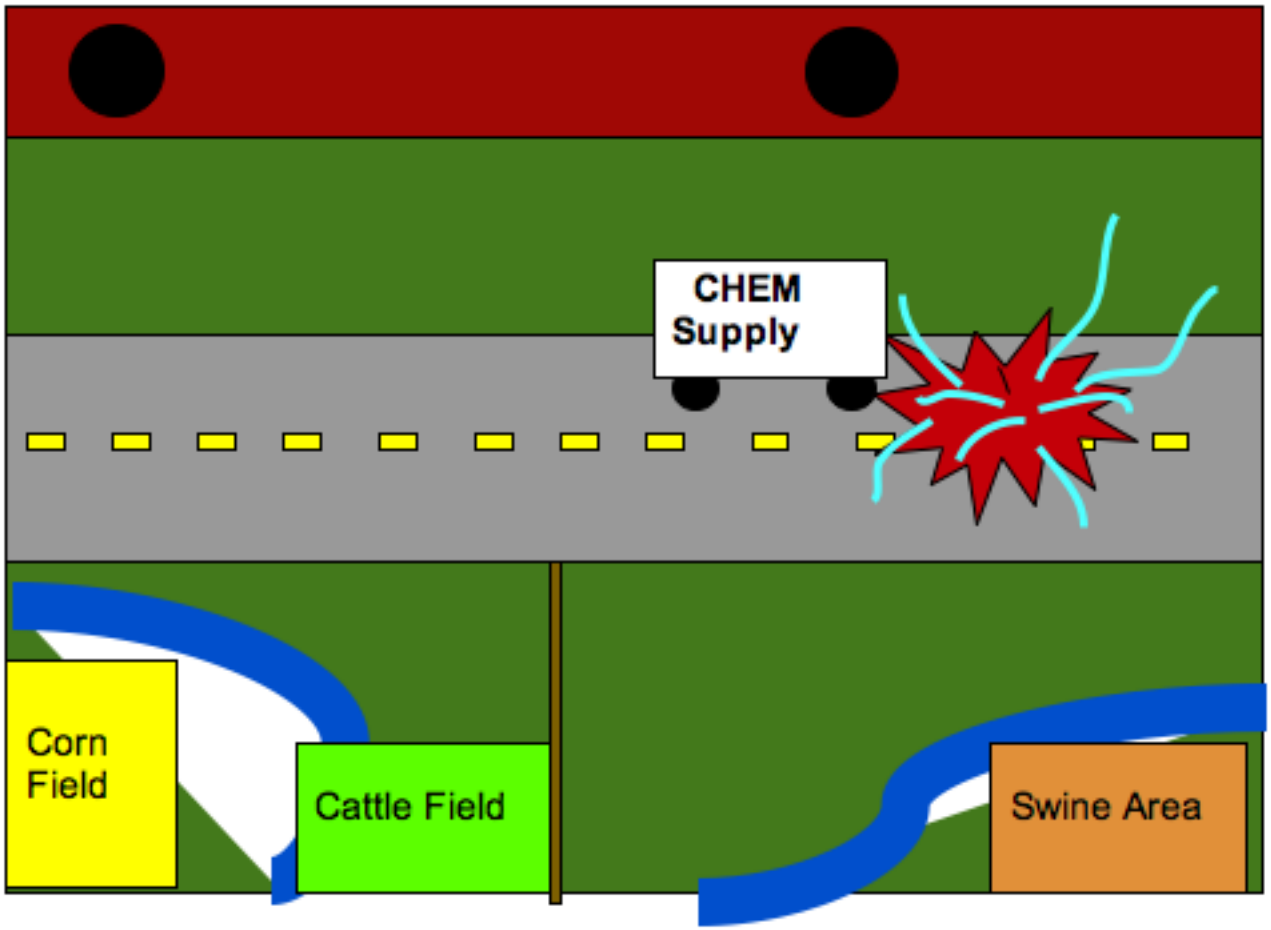

Exhibit B: Initial Accident Report

Date: July 2, 2016
Department: Woodford Sheriff Office
Case Number: 715717

Address: 274 Lexington Road		
City: Versailles	**State:** KY	**ZIP:** 40383
Name of Complaint Issuer: City of Versailles		
Complaint Description: Accident involving a semi-truck belonging to CHEM Supply Company, Inc. Chemical spill observed by first officer on site. Road runs through farmland on one side and an area of high industry on the other.		
Observations from Office: Upon arrival to scene, the semi-truck was turned on its side. The back doors of the truck were open. Observed glass, plastic, liquids, solids, boxes and other potential hazardous materials. Contacted SWS Emergency Spill Response Services. Their team arrived on scene and collected samples and observations of all chemicals and materials. Supervised the cleanup process that took approximately 7 hours. Sent copies of accident report and SWS report to city officials and CHEM Supply Company, Inc.		

Exhibit C: Complaint Report #1

Date: August 17, 2016
Department: Woodford Sheriff Office
Case Number: 715718

Address: 365 Lexington Road		
City: Versailles	**State:** KY	**ZIP:** 40383
Name of Complaint Issuer: Critter Craze Meadow Owner		
Complaint Description: Unknown, seemingly hazardous material in water supply.		
Interview: “This mornin’ I went out to check on the pigs. I have A LOT of pigs here. They have feedin’ bins, but they get their drinkin’ water from the creek. When I went down there, they wouldn’t drink the water. That’s when I noticed that some of the fish in the creek were floatin’ on top. There was so much algae in the water, I could barely see the rocks at the bottom. The fish are dead and I think it has somethin’ to do with that big spill a few weeks ago that happened right over there across the creek. That company needs to pay to clean up my creek so my animals don’t get sick.”		

Exhibit D: Creek Test Results from Complaint Report #1

Sample	Mass	Density	Odor	Color	Flammability	Solubility	Boiling Point	Melting Point
#1	40,472g	1.82	garlic	white	Yes	Slightly	280	44.2

The lab determined this pure substance to be phosphorous.

Exhibit E: Company Records for Chemicals that Were in the Supply Truck

Sample	Mass (g)	Density (g/mL)	Odor	Color	Flammability	Solubility	Boiling Point (°C)	Melting Point (°C)
#1	500	1.00	none	clear	Not	NA	100	32
#2	100	1.84	none	clear	Not	Yes	270	-35
#3	800	1.587	carmel	white	Yes	Yes	NA	186
#4	800	2.165	slight	white	No	Yes	1413	801
#5	100	2.532	none	white	No	Yes	NA	851
#6	500	7.86	none	black-gray	Yes	No	3000	1535
#7	200	4.25	garlic	red	No	Yes	113	43
#8	300	0.56	none	clear	No	No	34	-56

Sample	Mass (g)	Density (g/mL)	Odor	Color	Flammability	Solubility	Boiling Point (°C)	Melting Point (°C)
#9	200	13.55	none	silver-white	No	Yes	-196	-38.87
#10	500	1.14	pungent	yellow	Yes	NA	-188	-362

Exhibit F: Lab Results for Potential Chemical Reactions

Sample	Mass (g)	Density (g/mL)	Odor	Color	Flammability	Solubility	Boiling Point (°C)	Melting Point (°C)	Reactant or Product
#1	100	1.84	none	clear	No	Yes	270	-35	Reactant
#2	100	2.7	none	silver-white	No	No	2327	660	Reactant
#3	50	1.82	garlic	white	Yes	Slightly	280	44.2	Product
#4	150	1.43	none	clear	No	No	345	67	Product

The lab identified Sample 3 as phosphorus.

Exhibit G: Research about the area

- **The creek water in question normally has levels of nutrients that are in compliance with the EPA.**
- **The fertilizer used by a nearby corn farm contains high levels of nitrogen.**
    - "Nitrogen is a limiting reagent and usually a scarce commodity in a natural environment. However, man has introduced very large quantities of nitrates into the environment in the form of nitrates or anhydrous ammonia used as fertilizer."
- **The manure of livestock contain high levels of phosphorous.**
    - "Phosphorus plays a key role in growth of bones and teeth and in energy processes in livestock. Producers provide supplemental phosphorus to their stock to ensure that performance is not hindered by deficiency. Phosphorus is a common constituent of agricultural fertilizers, manure, and organic wastes in sewage and industrial effluent. Additional control of phosphorus from nonpoint sources (such as applications of lawn fertilizers and disposal of animal wastes) may be useful to maintain or improve the water quality in streams and lakes near growing urban areas. A sign of excess phosphorus is excess algae in the water.

PART B: Engaging in Argument from Evidence: Construct, use and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

Now that you have your data organized in a way to support your position on the case, you will develop an argument to explain how the chemicals that were found in the creek are evidence of the cause of the contamination. Your argument will need at least three pieces of evidence and associated reasoning to support your position. You may pre-write or organize in any way you like.

Kentucky Writing Rubric for Argumentation

Criteria For Evaluating Writing	Components
Communicating with an Audience through Purpose/Focus - Establishes and maintains an authentic purpose - Addresses an appropriate audience - Establishes and maintains an awareness of audience needs	- Establishes purpose by introducing a(n) opinion/claim; maintains focus throughout - Indicates awareness of audience's needs by providing relevant background; anticipating audience's knowledge level and concerns - Communicates purpose, responding to the anticipated needs of the audience by addressing reasons/alternate claims
Communicating with an Audience through Idea Development - Develops ideas with sufficient depth and complexity to support audience and maintain a focused purpose - Elaborates ideas with details, support & examples specifically relevant to the audience and purpose - Applies characteristics of the mode	- Demonstrates depth of idea development by using facts, details and examples to support opinions/argument - Supports opinions/claims with relevant, reliable evidence - Uses a variety of approaches to develop ideas (e.g., analysis, evaluation, specific facts, quotes) to support the opinion/argument
Communicating with an Audience through Structure - Demonstrates coherent and effective text structure in relation to the purpose - Includes a logical progression of ideas - Maintains coherence within and between paragraphs - Uses effective transitional elements within and between paragraphs guiding the reader through the text and clarifying the relationship of events, ideas, concepts or arguments - Maintains control of sentence structure - Varies sentence structure effectively	- Provides logically ordered reasons that are supported by facts and details. - Includes a logical progression of ideas - Maintains coherence within and between paragraphs - Links ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially) to guide the reader through the text and clarify the relationship of ideas, or opinions/ arguments - Maintains control of sentence structure - Varies sentence structure effectively
Communicating with an Audience through Language & Conventions - Selects and maintains word choices to communicate effectively with the audience - Employs voice and tone appropriate for audience and purpose - Communicates with audience effectively, applying correct grammar, usage and mechanics	- Uses words, phrases and clauses to clarify the relationships among opinion(s)/claim(s), reasons and evidence - Employs tone appropriate for the audience and purpose - Communicates effectively with audience applying correct grammar, usage and mechanics