

## Pattern Analysis of Student Thinking (PAST)

### 4-LS1-2 – Sensory Processing - Pillbug Assessment Task

PE - [Use a model to describe](#) that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

**DCI – Information processing**

- Different sense receptors are specialized for particular kinds of information, which may then be processed by the animal’s brain.
- Animals are able to use their perceptions and memories to guide their actions.

#### TASK 1 – Describe a photo of pillbugs in the soil.

Purpose	Student Response Themes	Examples of Student Responses	Possible Teacher Instructional Moves
<p>This question is designed to elicit and activate students’ prior knowledge. Additionally, students at this level should begin to distinguish observations and inferences and to understand that accurate and detailed observations lead to more valid inferences. Student responses to this question can indicate student thinking about the difference between observations and inferences.</p>	<p>Students provide descriptions</p>	<ul style="list-style-type: none"> <li>• Physical – <i>legs, antennae, body sections, rolled up in a ball</i></li> <li>• Environment – <i>rocky, dirt, leaves, hole in the dirt</i></li> </ul>	<p>If students provide inferences rather than observations about the picture, it provides an opportunity to have students make additional observations about other phenomena in order to practice making observations before making inferences from those observations.</p>
	<p>Students provide inferences</p>	<ul style="list-style-type: none"> <li>• What pillbugs are doing – <i>climbing, rolling, digging, finding food, working together</i></li> <li>• Type of environment – <i>wet, dirty, hole is a “cave”</i></li> </ul>	
<p><b>Focus SEP/CCC:</b> Students are <a href="#">obtaining and communicating information</a> about the physical <a href="#">structure</a> of pillbugs and the environment in which they can be found.</p>			

## TASK 2 - Ask questions about pillbugs that could be investigated.

Purpose	Student Response Themes	Examples of Student Responses	Possible Teacher Instructional Moves
<p>This question is designed to activate student thinking by engaging them in the process of asking scientific questions that can be tested through investigation. Student responses to this question should indicate their level of thinking about scientific (i.e. investigable or researchable) questions and non-scientific questions. They should begin thinking about questions they can investigate themselves to gather empirical evidence. Students will often ask questions that cannot be investigated directly, but the answers can be discovered through independent research. In the science classroom, students should begin to recognize non-scientific questions.</p>	<p>Investigable Questions</p>	<ul style="list-style-type: none"> <li>● <i>Do pillbugs prefer... light/dark, wet/dry, fruits/vegetables, hot/cold, soil/leaves?</i></li> <li>● <i>How fast do pillbugs move?</i></li> <li>● <i>What things make pillbugs roll up?</i></li> <li>● <i>How do pillbugs use their antennae?</i></li> <li>● <i>Can pillbugs swim?</i></li> </ul>	<p>If students pose mainly non-scientific questions this provides an opportunity to facilitate discussions about planning investigations to answer questions. Student groups can be given different questions and can discuss how best to investigate each question. This allows the students to determine that some questions can be investigated, some cannot be directly investigated in the classroom but can be researched, and some questions are cannot be answered through investigation or research.</p>
	<p>Researchable Questions</p>	<ul style="list-style-type: none"> <li>● <i>How do pillbugs... eat, smell, dig, see, sleep?</i></li> <li>● <i>Are pillbugs male or female?</i></li> <li>● <i>Why do pillbugs smell bad?</i></li> <li>● <i>Where can you find pillbugs?</i></li> <li>● <i>Do pillbugs have predators?</i></li> </ul>	
	<p>Non-scientific Questions</p>	<ul style="list-style-type: none"> <li>● <i>Are pillbugs friendly?</i></li> <li>● <i>Can you keep pillbugs as pets?</i></li> </ul>	

### Focus SEP:

Students are **asking questions** that can be identified as scientific (testable or researchable) questions to find out more about the natural world.

**TASK 3 - Analyze data to answer the question, "Do pillbugs prefer light or dark areas?"**

Purpose	Student Response Themes	Examples of Student Responses	Possible Teacher Instructional Moves
This question is intended to allow students to organize and interact with the data in a way that helps them see patterns and draw logical conclusions based on the observed patterns.	Accurately completed data table	Numbers or tally marks are in the appropriate columns	Students should be provided the opportunity to record and organize different types of data appropriately.
This question is intended to activate student thinking about how organisms sense things. Student answers may vary, however, the chosen structure should be logical.	<b>Question A</b> A pillbug structure used to sense its environment	The two most common responses are: <ul style="list-style-type: none"> <li>● eyes</li> <li>● antennae</li> </ul>	If students cannot come up with a logical sensing structure, they may need more experience identifying structures on other animals (including humans) that are related to the senses.
This question is intended to allow students to make a claim regarding pillbugs' preference in relation to dark and light areas.	<b>Question B</b> Student makes a claim regarding pillbug preference for dark or light	<ul style="list-style-type: none"> <li>● dark</li> <li>● light</li> <li>● both dark and light</li> </ul>	

<p>This question is intended to direct students to utilize data as evidence for the explanation about pillbugs' preference for dark or light areas. Students should be able to link pillbugs' preference to the provided data and the idea that the majority of pillbugs were found in dark environments. The lines of reasoning in these response types are shown from most connected to the data to least connected.</p>	<p><b>Question C</b> Explanation with evidence that matches the claim</p>	<ul style="list-style-type: none"> <li>● Column totals are larger for pillbugs in the dark. (ex. <i>Altogether the dark has 25 and the light has 11 pillbugs.</i>)</li> <li>● Group comparison – Most of the groups had more pillbugs in the dark. (ex. <i>Four groups have more in the dark and two groups have more in the light.</i>)</li> <li>● Group comparison – No clear preference shown. (ex. <i>Some pillbugs are in the dark and some are in the light, so they must like both.</i>)</li> <li>● No explanation of how data provides evidence             <ul style="list-style-type: none"> <li>▪ <i>It showed this in the chart.</i></li> </ul> </li> <li>● No use of data from the investigation             <ul style="list-style-type: none"> <li>▪ <i>Pillbugs live under rocks so they must like dark.</i></li> <li>▪ <i>I just know they do.</i></li> </ul> </li> </ul>	<p>If students do not make a connection to the data in their explanation they should be given the opportunity to analyze different types of data and to make inferences based on observable patterns in the data. Students can use number lines, tally marks, or other strategies to determine relative numbers related to groups within a given data set. Facilitated discussions can be used to guide students to make logical conclusions from a set of data.</p>
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**Focus SEP/CCC:**  
Students are **analyzing and interpreting data** to **construct explanations** of observed **patterns** that explain pillbug behaviors.

**Note:** The terms stimulus and response are used in explaining Task 4. However, this is only a common scientific term for the cause and effect relationship that occurs when organisms sense and respond to their environment. These are not necessarily terms that 4<sup>th</sup> graders will use or need to know. They are used here to help name and identify facets of student thinking about this concept.

**TASK 4 - Utilize data from a table to explain how pillbugs use different body parts to sense their environment and then respond to it in different ways.**

Purpose	Student Response Themes	Examples of Student Responses	Possible Teacher Instructional Moves
<p>Students should note patterns that reflect sensing of a stimulus by a body structure of the pillbug and a corresponding response that helps it do something to meet its needs. These patterns show cause and effect relationships.</p>	<p><b>Question A</b> Evidence of antenna sensing a stimulus followed by a response</p>	<ul style="list-style-type: none"> <li>● Pillbug moved after touching the block with its antenna</li> <li>● Pillbug ate the apple after touching it with its antenna</li> <li>● Pillbug rolled up after its antenna was touched</li> </ul>	<p>Provide students with additional opportunities to observe stimulus-response interactions and make associations between the cause (stimulus) and the effect (response).</p>
	<p><b>Question B</b> Evidence that gills sense moisture and respond</p>	<ul style="list-style-type: none"> <li>● Pillbug rolled in a ball on the dry paper towel</li> <li>● Pillbug unrolled on the wet paper towel</li> </ul>	

**Focus SEP/CCC:**

Students are **analyzing and interpreting data** to **construct explanations** of observed **patterns** that explain pillbug behaviors.

**TASK 4 (continued) – Create a model of a stimulus-response event and use it to explain how pillbugs receive information through their senses and respond to the information.**

Purpose	Student Response Themes	Examples of Student Responses	Possible Teacher Instructional Moves
<p>Students should be able to select an appropriate investigation and create a model that effectively communicates an explanation. An effective model is one that explains (or can be used to explain) a series of cause and effect events. The diagram should have sufficient detail to convey both the cause (change that was made to the environment) and the effect (how the pillbug responded). A more effective model will include labels, arrows, speech bubbles, etc. in addition to the diagram.</p>	<p><b>Question C</b></p> <p>A drawing that represents a stimulus and response event from one of the five investigations in the class notes</p>	<ul style="list-style-type: none"> <li>● Drawing with labels and/or speech bubbles to explain what is happening</li> <li>● Drawing with arrows that portray action that occurred during the event</li> <li>● Drawing only (no labels, speech bubbles, or arrows)</li> </ul>	<p>If students have difficulty creating effective models they should be given additional opportunities to view, analyze, and critique other stimulus/response cause and effect models in groups (e.g. dog barks when it sees the mailman or person jumping when hearing a loud noise). Stimulus/response cause and effect models can also be constructed through whole class participation.</p>

<p>Students should be able to provide a written explanation that matches the model they created and relates to the data in the chart. The students' explanations should describe the relationship between the pillbug's body structure, the stimulus it senses, and how the pillbug responds to the stimulus. Sentence stems can be used to differentiate for students at different levels. Possible sentence stem for the relationship:</p> <p>The pillbug uses <b>[body structure]</b> to sense <b>[stimulus]</b> and responds by <b>[action]</b>.</p>	<p><b>Question D</b></p> <p>Explanation matches the drawing and relates to the data in the chart</p>	<ul style="list-style-type: none"> <li>● Information was received - (e.g. <i>block in the way</i>)</li> <li>● How it was sensed – (e.g. <i>pillbug “felt” the block with its antenna</i>)</li> <li>● What was the response – (e.g. <i>pillbug moved around the block</i>)</li> </ul>	<p>If students have difficulty constructing an appropriate explanation, provide additional opportunities to observe stimulus response interactions and make associations between the cause (stimulus) and the effect (response). Students can collaborate in small groups or whole class to construct logical explanations for each stimulus-response interaction.</p>
<p><b>Focus SEP/CCC/DCI:</b>          Students are <b>creating a model</b> based on <b>evidence</b> from data to describe the <b>cause and effect</b> relationship between <b>stimulus and response</b> in pillbugs, which helps them to act in ways that help them <b>survive in their environment</b>.</p>			