Welcome!

Assessing 3D Learning Using the NSTA Student Work Analysis Protocol

NSTA National Conference on Science Education
Denver, Colorado
Friday, March 22, 2024, 2:40 pm - 3:40 pm
Introductions

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Session Description

Learn how to use the NSTA Student Work Analysis tool and protocol to evaluate students’ three-dimensional learning. We’ll focus our discussions on what counts as evidence of students’ ownership of targeted elements of the three dimensions and how to use collected student data to inform instruction.
Collection of Resources

Denver24: Assessing 3D Learning Using the NSTA Student Work Analysis Protocol Collection

Resources in “Denver24: Assessing 3D Learning Using the NSTA Student Work Analysis Protocol” Collection

<table>
<thead>
<tr>
<th>Title</th>
<th>Resource Type</th>
<th>Open in Library</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Framework for K-12 Science Education (pdf)</td>
<td>Web Page</td>
<td></td>
</tr>
<tr>
<td>A New Vision for Science Education</td>
<td>Web Page</td>
<td></td>
</tr>
<tr>
<td>Why do dead things disappear over time? [Grade 5] Storyline Outline</td>
<td>Web Page</td>
<td></td>
</tr>
</tbody>
</table>

https://my.nsta.org/collection/Q4LgDLD2uqk_E
Assessing Students’ 3D Learning

Student Artifacts of Three-Dimensional Learning

Student Work Analysis Protocol

STUDENT WORK ANALYSIS PROTOCOL

Teacher: __________________________ Date: __________________________

What were the three-dimensional (3D) learning goals for students? (Lesson-level performance expectation)

<table>
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<tr>
<th>Scientific/Engineering Practice element(s)</th>
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<th>Crosscutting Concept element(s)</th>
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</thead>
</table>

- of the students’ reasoning?
- address the task/question as it was asked?
- among the samples? Is there evidence of divergent thinking?

What teacher decisions might have led to these results?

What is the next step in learning for these students?

What is the next step for you learning about your practice?
**Student Work Analysis Protocol**

**Alone Zone**

Familiarize yourself with the Student Work Analysis tool.

- What can we learn about our students’ ownership of the targeted knowledge (and skills)?
- What can we learn about the assessment task?
- What might we learn about our instruction (or implementation of the instructional materials)?

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### Student Work Analysis Protocol

<table>
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<th>Crosscutting Concepts element(s)</th>
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- **What were the three-dimensional (3D) learning goals for students? (Lesson-level performance expectations)**

- **Of the students’ reasoning?**  
  - Address the task/question as it was asked?  
  - Among the samples? Is there evidence of divergent thinking?

- **What teacher decisions might have led to these results?**

- **What is the next step in learning for these students?**

- **What is the next step for you learning about your practice?**
Partners or Trios

Share your initial thinking and record any questions that arise.

- What can we learn about our students’ ownership of the targeted knowledge (and skills)?
- What can we learn about the assessment task?
- What might we learn about our instruction (or implementation of the instructional materials)?

We’ll come back to this...
Student Artifacts of 3D Learning

How did we get here? Unit context:

- Anchoring phenomenon
- Identify conditions in which plants grow
- Matter takes up space and has weight (mass)

What do we want students to show they know and are able to do (through this task)?
Unit Context

Storylines

Why Don’t Antibiotics Work Like They Used to?
How Can Science Help Make Our Lives Better?
How Do Small Changes Make Big Impacts on Ecosystems? (Part 1)
How Do Small

Why Do Dead Things Disappear Over Time?

UNIT SKELETON 

LESSONS

MATERIAL & SUPPLY LIST

SYNOPSIS

Storyline Outline (aka Unit Skeleton) resource #3 in the collection
Related Phenomena

Flat rat

Newborn mouse / see through skin
rat in the street w/ bones
fish in grass it was flat
Squirrels in road w/ bones
Squirrel on sidewalk could see insides
could see white worms in fur inside

3 baby birds on sidewalk
Big bird at park
Dead chicken on hay
Rat with hole in it, with insides cut
and flies all over
Unit Context - L1 Anchoring Phenomenon

Related Phenomena

- Flat rat
- Newborn mouse / see through skin
- Rat in the street w/ bones

Investigation Ideas

(To gather evidence for what happens to the body of a dead animal over a couple days or weeks)

- Field trip - pictures over time
- Bring dead animal into classroom
- Go pig in tree...
- Soil + dead fly in a cup - watch over time
- Put a rat trap out to catch a rat + observe
- Soil + worms...

Internet: look for pics + videos safest + legal!
Unit Context - L2 Anchoring Phenomenon

Students observe time lapse video of dead badger

Initial Model

Q1: Making Sense: In the space below, draw and label a model to show what is causing the changes you observed.
Unit Context - L2 Anchoring Phenomenon

**Turn and Talk**

What other living things besides animals die?

**Individually**

Would you expect to see similar changes in plants or in parts of dead plants that fell to the ground over time?
Unit Context - L2 Anchoring Phenomenon
## Unit Context - L9 Investigation

<table>
<thead>
<tr>
<th>Environment</th>
<th>Plant</th>
<th>Weight of this plant on Week 0</th>
<th>Projected Weight of this plant on Week 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment #1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1.8g</td>
<td>2.8g</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>1.6g</td>
<td>2.3g</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>2.2g</td>
<td>3.2g</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>1.7g</td>
<td>2.6g</td>
<td></td>
</tr>
<tr>
<td>Environment #2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>2.0g</td>
<td>0.1g</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>1.7g</td>
<td>0.1g</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>1.4g</td>
<td>0.1g</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>2.5g</td>
<td>0.1g</td>
<td></td>
</tr>
<tr>
<td>Environment #3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>1.6g</td>
<td>1.6g</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>1.6g</td>
<td>1.6g</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>2.6g</td>
<td>2.6g</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>1.3g</td>
<td>1.3g</td>
<td></td>
</tr>
<tr>
<td>Environment #4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>2.6g</td>
<td>1.6g</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>2.2g</td>
<td>1.6g</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>1.0g</td>
<td>0.7g</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>1.9g</td>
<td>1.5g</td>
<td></td>
</tr>
</tbody>
</table>
Students figure out that plants require **sunlight, water, and air** to grow (leaves and roots get longer, weight increases).

Plants *do not* need soil to grow.
## Unit Context - L10 Investigation

<table>
<thead>
<tr>
<th>Takes up space?</th>
<th>Has weight?</th>
<th>Is it matter?</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>
### Unit Context - L10 Investigation

<table>
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<th>Takes up space?</th>
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</tr>
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<tbody>
<tr>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Students figure out that <strong>water</strong> and <strong>air</strong> can provide matter to the plant that it needs to grow (leaves and roots get longer, weight increases).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sunlight can *not* provide matter to the plant that it needs to grow.
Students figure out that air can be added to a toy basketball from a hand pump and reason that they can represent air using particles (like they have represented small amounts of liquids and solids in previous models) to show that transfer of air.
Phenomenon

This plant is left in this container in a well lit room, and no dirt is added to the container. It is left open to the air, so that water can be added to cover its roots every week.

It is taken out of the container every four weeks, dried off, and weighed, and then put back into the container. These were the results:

<table>
<thead>
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The person recording this data also notices that the leaves and roots are much longer on week 20 than they were on week 0.
Assessing Students’ 3D Learning

Student Artifacts of Three-Dimensional Learning

Student Work Analysis Protocol
Assessing Students’ 3D Learning

**Phenomenon:** After 20 weeks, plants in water (no soil) show visible growth - increase in length of leaves and roots - and a measurable increase in mass.

**Lesson-Level Performance Expectation:** Develop a model to explain why the spider plants that had no soil, but had their roots (structure) in water and leaves (structure) were in the air (open system) gained weight and grew over time.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop a model to explain a phenomena</td>
<td>Plants acquire their material for growth chiefly from air and water</td>
<td>Matter is transported into, out of, and within systems. A system can be described in terms of its components and their interactions.</td>
</tr>
</tbody>
</table>

### STUDENT WORK ANALYSIS PROTOCOL

- **Overall, what might be the strengths of the student’s reasoning?**
- **How well does the student work address the task/question as it was asked?**
- **What differences are there among the samples? Is there evidence of divergent thinking?**

- **What teacher decisions might have led to these results?**
- **What is the next step in learning for these students?**
- **What is the next step for you learning about your practice?**
Assessing Students’ 3D Learning

STUDENT WORK ANALYSIS PROTOCOL

**Teaching**

What were the three-dimensional (3D) learning goals for students? (Lesson-level performance expectation)

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**Cell**

- Data

**Model**

- Data

**Method**

- Data

What does the student have learned? (Is the task question as it was asked?)

What information can you infer from the sample? Is there evidence of divergent thinking?

What decisions might have led to these results?

What is the next step in learning for these students?

What is the next step for you learning about your practice?
Evaluate Student Model 2

Use the Plant Matter Rubric to evaluate Student Model 2.

Assign a score (1, 2, 3, or 4) for each of the three key features of a model **based on evidence**:

- components
- relationships
- mechanisms

**Evidence** means you can point to, highlight, and/or quote specific text, images, tables, etc., in the student work.
Relationships: **Model** includes **none**, **one**, **two** or **all** of the following relational aspects: arrows that clearly show plant growth, where the water particles enter the plant, and where the air particles enter the plant.
Evaluate Student Model 2

Student shows air going into the plant (arrows). However, no air particles are shown in the plant.

Student does not communicate by any means (words, pictures and/or symbols) that the plant is growing or has grown.

Student may understand that water is going into the plant - shows water particles inside and outside the plant - but not explicit.
Evaluate Student Model 2

Relationships: **Model includes one** of the following relational aspects: arrows that clearly show plant growth, where the water particles enter the plant, and where the air particles enter the plant. (**Level 2**)

- Student shows air going into the plant (arrows). However, no air particles are shown in the plant.
- Student does not communicate by any means (words, pictures and/or symbols) that the plant is growing or has grown.
- Student may understand that water is going into the plant - shows water particles inside and outside the plant - but not explicit.
Evaluate Student Model 2

Partners or Trios
Use the Plant Matter Rubric to evaluate Student Model 2.

Assign a score (1, 2, 3, or 4) for each of the three key features of a model:

- components
- relationships
- mechanisms
Student shows air going into the plant (arrows). However, no air particles are shown in the plant. R

Student does not communicate by any means (words, pictures and/or symbols) that the plant is growing or has grown. R

Student may understand that water is going into the plant - shows water particles inside and outside the plant - but not explicit. R

Student does not explain why the phenomenon occurs (plant growth is not shown on the model) M

Student includes all components that are conceptual aspects used to represent important features of the phenomenon: water particles, air particles, and the plant C
Evaluate Student Model 2

Components: Level 4

Relationships: Level 2

Mechanism: Level 1

Student includes all components that are conceptual aspects used to represent important features of the phenomenon: water particles, air particles, and the plant C.

Student shows air going into the plant (arrows). However, no air particles are shown in the plant. R

Student does not communicate by any means (words, pictures and/or symbols) that the plant is growing or has grown. R

Student may understand that water is going into the plant - shows water particles inside and outside the plant - but not explicit. R
Evaluate Student Models

Small Group(ish)

Use the Plant Matter Rubric to evaluate Student Model 1, 3 and/or 4.

- Count off “1”, “3”, “4” at your table (continue counting in this way until everyone at your table has an assigned number).

- Use the rubric to evaluate your assigned student model (components, relationships, and mechanism). Be prepared to support your scores with evidence you can point to on the student model.
Evaluate Student Models

Small Group - 1

- Move to your designated area in the room. Bring your rubric and assigned student model with you.
- Compare your scores (components, relationships, and mechanism) with your group.
- Reach consensus on your scores.
Evaluate Student Models

Small Group - 2

● Return to your tables.
● What patterns do you observe across the four student models?
  ○ What knowledge (and skills) are students **most secure** with?
  ○ What knowledge (and skills) are students **still developing** (not all-the-way-there)?
  ○ What questions do you have about noticings that are not accounted for on the rubric?
Assessing Students’ 3D Learning

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1. How did we decide to represent different types of really small pieces of matter moving from one thing to another?

2. Develop a model to help explain why the plant in the environment A (from our researcher’s data) kept growing, using the particle representation above.

3. Develop a model to help explain why the plant in the environment A (from our researcher’s data) kept growing, using the particle representation above.

4. Develop a model to help explain why the plant in the environment A (from our researcher’s data) kept growing, using the particle representation above.
Student Work Analysis Protocol

Small Group - 3

- What are the strengths of the student reasoning?
- How well does the student work address the task/question as it was asked?
- What difference are there among the samples? Is there evidence of divergent thinking?

Be ready to share with the whole group.
1. How did we decide to represent different types of really small pieces of matter moving from one thing to another?

2. Develop a model to help explain why the plant in the environment A (from our researcher's data) kept growing, using the particle representation above.

2. Develop a model to help explain why the plant in the environment A (from our researcher's data) kept growing, using the particle representation above.

The Sun gives light to the plant but light does not have matter but light gives the plant energy to grow. The plant uses this energy to grow. The air and water give the plant the matter it needs to grow.
Student Work Analysis Protocol

Small Group - 4

• What teacher decisions may have led to these results?

• What is the next steps in learning for these students?

• What is the next steps for you learning about your practice?

Be ready to share with the whole group.
Student Work Analysis Protocol

Small Group - 4

• What teacher decisions may have led to these results?

• What is the next steps in learning for these students?

• What is the next steps for you learning about your practice?
What is something the students (collectively) can do differently next time they create an explanatory model?
What is something the students (collectively) can do differently next time they create an explanatory model?
I noticed some of the models used only words to explain how plants gained matter.

- How could you use symbols and/or pictures to show how the different types of particles are adding matter to the plant over time?
- How could you show the particles causing the leaves and roots to grow over time? (How we represented change over time in the past?)
Whole Group

- What can we learn about our students’ ownership of the targeted knowledge (and skills)?
- What can we learn about the assessment task?
- What might we learn about our instruction (or implementation of the instructional materials)?
Be an NSTA Conference Reviewer!
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Kristin Rademaker
NSTA Professional Learning Specialist
krademaker@nsta.org
Together, we are NSTA.

Please review this session.