Bridging the Gap: Evaluating a Design Approach for Curriculum-Neutral NGSS Benchmark Assessments in Middle School

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The Lawrence Hall of Science

Project Description

- Four-year project (concluding 2022)
- Funded by The Carnegie Corporation of New York
- Goals:
  - Design summative, NGSS-aligned, curriculum-neutral, three-dimensional assessment items for all middle school Performance Expectations
  - Freely provide assessments for educator use and adaptation

Research Questions

- Does the project approach lead to the design of items that elicit 3D student performances aligned to the NGSS PEs?
- Are these items curriculum-neutral in that they are accessible to students regardless of their curriculum of instruction?

Data Types

Multi-Curriculum Group Reviews: FOSS, The Learning Design Group, SEPUP (project lead)

External Expert Panel Review: Review by external panel of NGSS-assessment experts for each item set with specific criteria

Cognitive Labs*: Conducted with middle school students, varied experience levels with science/PE content

Field Tests*: Conducted with middle school students who had been taught PE content

*Covid-19 disclaimer

Question One: Does the project approach lead to the design of items that elicit 3D student performances aligned to the NGSS PEs?

We looked at…

- external expert review: individual items and overall item sets scored on three-dimensionality and alignment to NGSS, with annotations and comments provided
- cognitive lab interviews: Did student interviewees attend to all three dimensions as prompted by questions? Were there patterns in where clarification was needed?
- field test responses: scored using item-based rubrics for accuracy and clarity of 3D responses

Question One: Does the project approach lead to the design of items that elicit 3D student performances aligned to the NGSS PEs?

Generally the data showed…

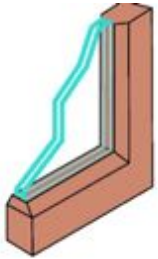
- external expert review: >80% rated 3 or above for eliciting 3D responses
- cognitive lab interviews: completeness of response depended heavily on clarity and formating of prompt
- field test responses: aligned with cog lab data; items with clear prompts elicited a full range of responses; complete responses, regardless of accuracy, demonstrated three-dimensionality

Characteristic Task Features (CTF)

Provide a scenario/phenomenon	• 2-3 sentences • Describe a phenomenon or set the stage for phenomenon to occur/be predicted
Provide a basic structure for the model	• Background drawing (e.g. mountain scene with lake and rivers for question around Earth Science model of water cycle), OR • Model components (e.g. a key with simple figures and symbols to use in drawing their model), OR • A model for a related phenomenon
Provide language that prompts model construction	• Add (arrows and) labels to the diagram below to show why/how/what happens… OR • Add (arrows and) captions to the diagram below to explain why/how/what happens…
Prompt to use the model to explain	• Use your/the model to construct an explanation…
Possible scaffold	• Be sure to include...in your explanation/in your model

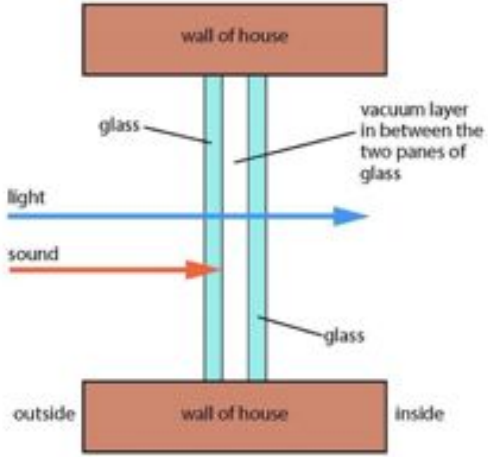
Assessment Item for MS-PS 4-2 Initial Item Draft

Eric was at his friend's apartment and noticed that he couldn't hear much street noise through the window. His friend's mother explained that the window was designed with two panes of glass separated by a vacuum layer where all the air had been removed. She drew a sketch of the window on a piece of paper.



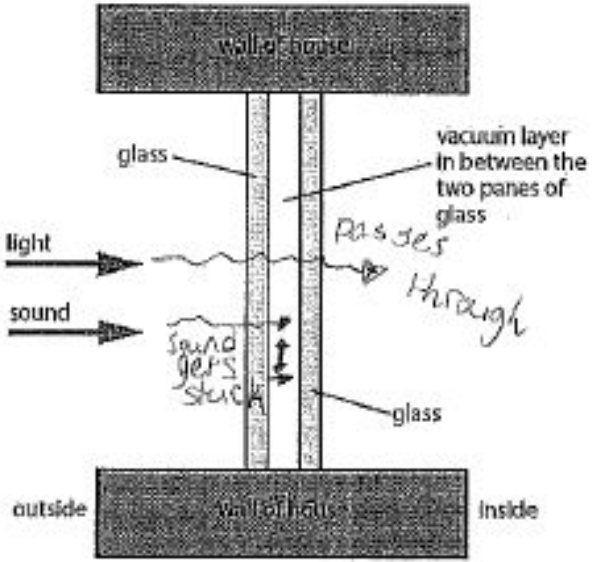
3D sketch of the window with two panes of glass

On the diagram below, draw what happens after light and sound enter the window. Describe how the structure of the window helps to reduce the noise from the street.



Cross-section of the window in the apartment

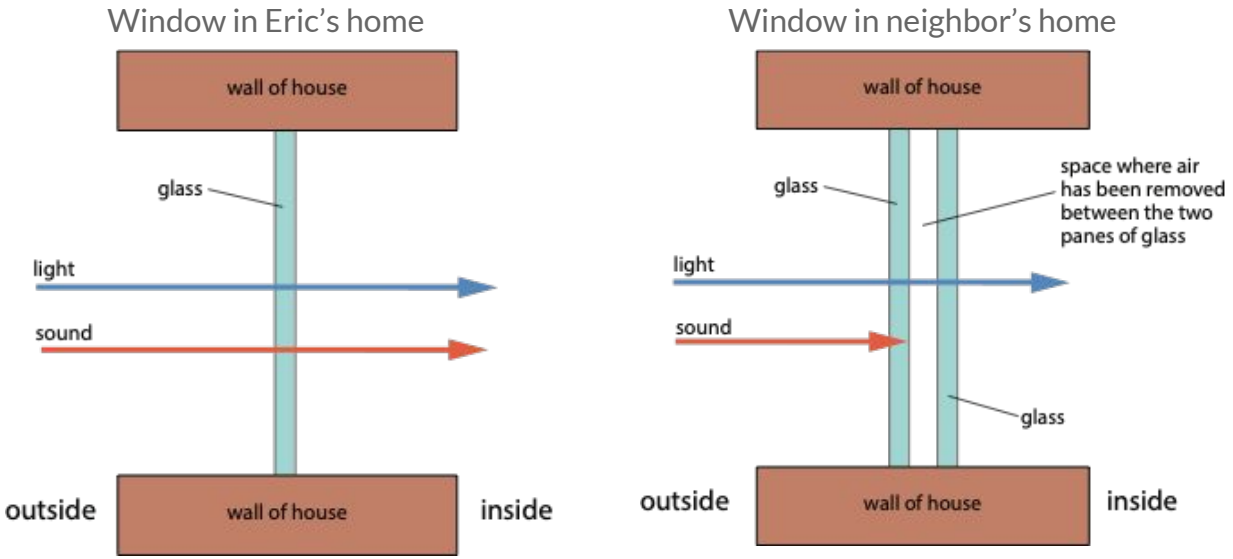
Sample Student Field Test Response for MS-PS 4-2 Item



The structure of the window helps to reduce sound from the street because the vacuum layer traps sound. Sound cannot travel through a vacuum because it is a mechanical wave, which needs matter to travel.

Assessment Item for MS-PS 4-2 Post-revisions

Eric was visiting his neighbor's home. He noticed that less outside noise could be heard than in his home. He compared the designs of the windows in the two homes. The ones in his home had a single pane of glass. The ones in the neighbor's home were designed with two panes of glass separated by a space where all of the air had been removed.



Cross-sections of the windows in the two houses

a) On the diagrams above, draw what happens when light and sound from the outside reach the window of each house.

b) Explain why the structure of the neighbor's window helps to reduce the noise from outside more than Eric's window. Be sure to use your knowledge of sound and light as waves in your answer.

Key Revision Takeaways

- Simplify model and scenario to remove unnecessary information and more tightly link to main body of item
- Better elicit crosscutting concept (structure AND function)
- Better prompt students to respond to ALL parts of the question

Question Two: Are these items curriculum-neutral in that they are accessible to students regardless of their curriculum of instruction?

We looked at…

- curriculum group reviews: how did each curriculum treat the standard? Would each item work for students from a given curriculum?
- external expert review: individual items scored on language being clear and appropriate for middle school students, with annotations and comments provided
- cognitive labs: were student interviewees able to engage with the items regardless of background experience?
- field test responses: Were students at different schools equally able to engage with the items?

Question Two: Are these items curriculum-neutral in that they are accessible to students regardless of their curriculum of instruction?

Generally the data showed that…

- curriculum group reviews: generate suggestions for simple modifications
- external expert review: 80% of items rated 3 or above for prompt clarity and appropriateness for middle school students (3 = modest revisions suggested)
- cognitive labs: students from a range of schools and grade levels could engage with the items
- field test responses: data across school sites indicated a range of student scores for each item set

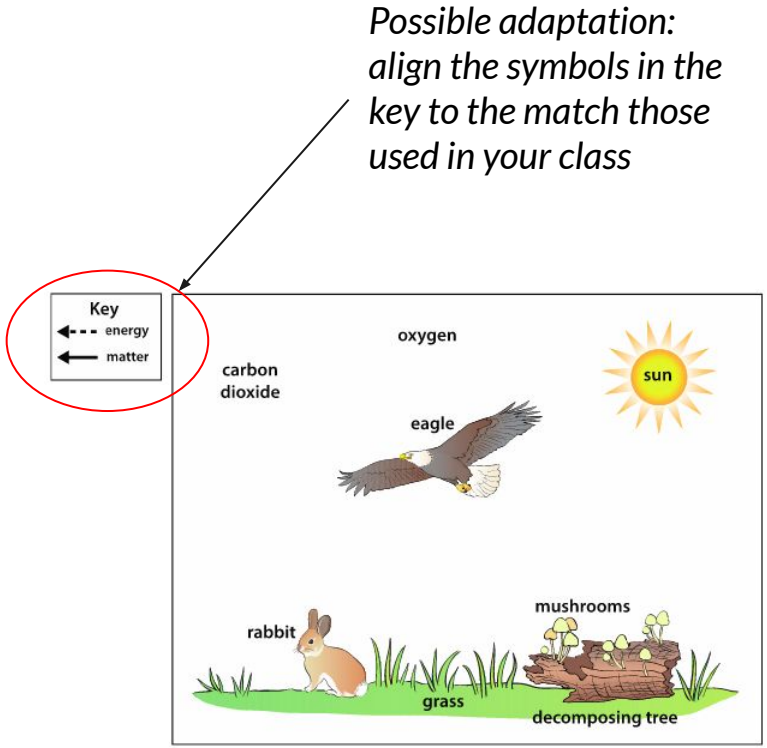
Sample Curriculum-Specific Adaptations

Vocabulary Choice:

- Particles vs. atoms
- Transform vs. convert

Visualizations:

- Curriculum-specific standardized representations



PE MS-ESS 2-6

MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. *[Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]*

PE MS-ESS 2-6 - Curricula Interpretations

Curriculum A

Phenomenon: Climate change is slowing the global conveyor belt (system of ocean currents).

Content Emphasis: the role of density in driving ocean currents

Curriculum B

Phenomenon: The air temperature of a location has a pattern of warmer years and cooler years.

Content Emphasis: the role of ocean currents in distributing energy and the effect on regional climates

Curriculum C

Phenomenon: Local and global winds follow predictable patterns.

Content Emphasis: the role of uneven heating of Earth's surface in driving air movement

Example Item Prompt with Feedback for PE LS 1-5

Initial Prompt:

Samira and her father go to the plant nursery and find 12 young snapdragon plants that are labeled “yellow flowers.” They plant them in the garden in the same kind of soil and give them the same amount of water and sunlight.

After 4 weeks, all the plants are healthy. But they are different heights and shades of yellow, as shown in the picture below. About half of them are very short and dark yellow (about 18 cm high) and the other half are tall (45 cm high) and light yellow. What might cause the differences in the plants? Explain your answer.*

*Drawing of plants before and after included in actual item.

Example Item Prompt with Feedback for PE LS 1-5

Cognitive Lab Feedback:

She [student interviewee] was confused by the prompt that stated that the "12 young snapdragon plants that are labeled 'yellow flowers.'" She didn't understand why these details were necessary. She thought you could either say snapdragons or yellow flowers, but saying both was confusing. She was confused that they were labeled two different ways.

Expert Review:

"Consider deleting 'snapdragon' in the first sentence. It isn't used elsewhere, and in the rest of the description 'yellow flowers' is used and seems sufficient. Otherwise, it looks good."

Lessons Learned - Broadly Applicable

- General alignment of PE interpretations - curriculum-neutral, 3D assessments are possible for all MS PEs
- Eliciting 3D responses - particular attention to clarity and formatting of prompts
- The scenario is about setting up the assessment, not about telling a story
- Task features based on practices can be applied across PEs

Lessons Learned - Limitations

- Different interpretations happened consistently across PEs, in general:
  - Physical Science - vocabulary choices
  - Life Science - visual representations
  - Earth System Science - broad content in PE/DCI = selected content coverage (and phenomena choices)
- Some PEs were easier to develop assessments for than others
  - Some practices didn't lend themselves to eliciting 3D understanding
  - Some PEs are too big, some are too small, some are just right
- Limitations to "paper and pencil" assessments (as opposed to hands-on)

More for the Field

- Comprehensive nature of this project highlighted how many tough choices are being made by developers, curricula, teachers, and others in terms of PE coverage during a year/course/middle school.
- Items will all be available online later this year

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Slides and paper will also be posted at https://sepuplhs.org/news.html