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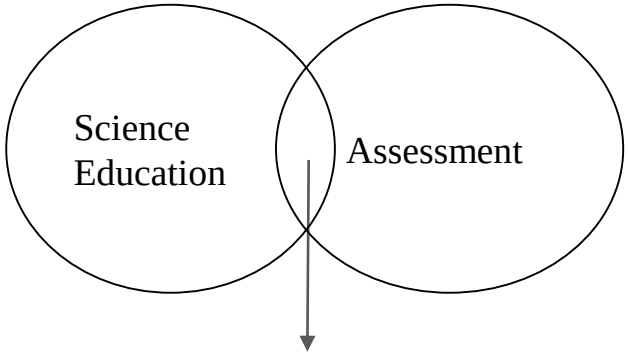
Research Interests



- Assessment Design (classroom based)
- Supporting teachers use of assessments for formative purposes
- Student multi-dimensional Learning
- Social Justice & Classroom based assessments

Portraits of Teachers' Enactments of Instructionally Informative Assessment Tasks

Examples from Middle and Primary Grade Science Classrooms with Implications for Teacher Practice & Assessment Design

By
Sania Zaidi

UIC Learning Sciences Research Institute

Wave of Reform

- Across a variety of science reform efforts, views of what it means to be literate and proficient in science are changing from the traditional view that conceptual knowledge is paramount.

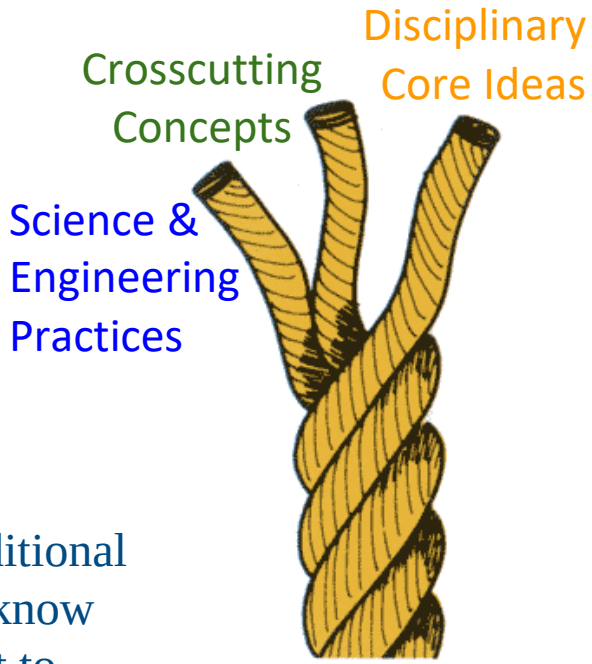
In the United States, there is a vision laid out for science proficiency where there is an integration of science practices with conceptual knowledge (disciplinary core ideas, and crosscutting concepts) (A Framework for K-12 Science Education, National Research Council. 2012; NGSS Lead States, 2013)

Reform efforts in the EU have advocated transforming science instruction to focus on inquiry based pedagogy.

Hong Kong's Curriculum Development Council (2015) emphasizes that STEM education should promote hands-on learning which enable students to "integrate and apply" their prior knowledge and skills from different subject disciplines to address real-life problems.

A Framework for K-12 Science Education & the Next Generation Science Standards (NGSS)

- Promote *3-dimensional learning*
- Explain phenomena and design solutions to solve problems
- Develop deep understanding and skills over time and across the domains.



With the new emphasis on learning that is a departure from traditional science learning, there is a need more than ever for teachers to know where students are in their 3-dimensional learning and how best to support them.

Learning & Formative Use of Assessments

- Assessments designed to be instructionally informative can be a useful tool that provides information to teachers about where students are in their learning and help with instructional adaptations.
- Decades of research have demonstrated that formative use of assessments are a powerful catalyst for learning (e.g., Andersson & Palm, 2017; Black & Wiliam, 1998; Decristan et al., 2015; Lee et al., 2020; Popham, 2011)
- It has shown to provide support to a diverse group of students (e.g., Bishop et al., 2009; Hill et al., 2017)

Formative Use of Assessments: Salient Characteristics

1. **Is a process**
   - *‘ … formative assessment is not a test but a process…’ (Popham, 2008).*
1. **Is used by teachers and students during instruction**
2. **Provides feedback to adjust ongoing teaching and learning**
   - *Formative assessment is a process used by teachers and students during instruction that provides feedback to adjust ongoing teaching and learning to improve students’ achievement of intended instructional outcomes (Popham, 2008).*
1. **Recognizes and responds to student learning to enhance that learning during the learning**
   - “*The process used by teachers and students to recognise and respond to student learning in order to enhance that learning, during the learning.” (Cowie & Bell,1996, p.3)*
1. **Produces insight into student understanding**
   - *The process produces not so much a score as a qualitative insight into student understanding (Shepard, 2008).*
2. **The results are used to adapt the teaching**
   - *The distinguishing characteristic is ‘ … when the [results are] actually used to adapt the teaching to meet student needs’ (Black and Wiliam 1998b, p.140).*

Formative Use of Assessments: Key Strategies

Formative use of assessments can be conceptualized as consisting of five key strategies (Wiliam & Thompson, 2007):

1. Clarifying and sharing learning intentions and criteria for success;
2. Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding;
3. Providing feedback that moves learners forward;
4. Activating students as instructional resources for one another; and
5. Activating students as the owners of their own learning.

Formative Use of Assessments & Instruction

Teachers often do not feel well prepared to formatively assess (Banilower et al., 2018).

When examining the definitions and the key strategies, it is clear that the practices involved with enacting formative assessment are embedded in many research-based frameworks for quality teaching and learning.

- "eliciting and interpreting student ideas" and "coordinating and adjusting instruction during a lesson" are two high-leverage practices (e.g., Ball & Forzani, 2009; 2011)
- "eliciting student ideas" and "supporting ongoing changes in thinking" are two core practices in the Ambitious Science Teaching Framework (Windschitl et al., 2012).

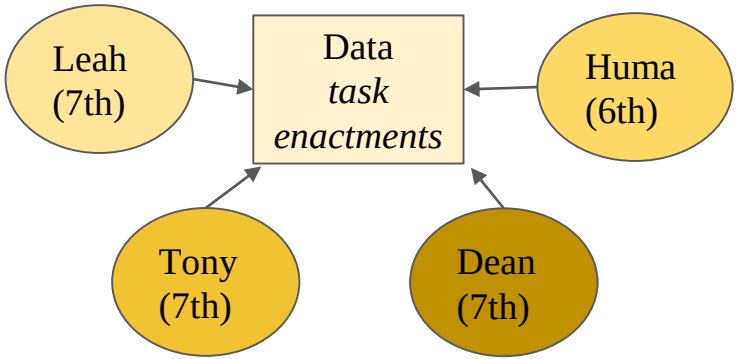
Therefore, I propose that illustrating how the practices of formatively assessing fit into teachers' larger instructional schema can help provide all teachers with a more coherent picture of how instruction and formative use of assessments fit together.

Research Question:

How do teachers use instructionally informative assessment tasks as part of their instructional schema in order to inform their multi-dimensional instruction?

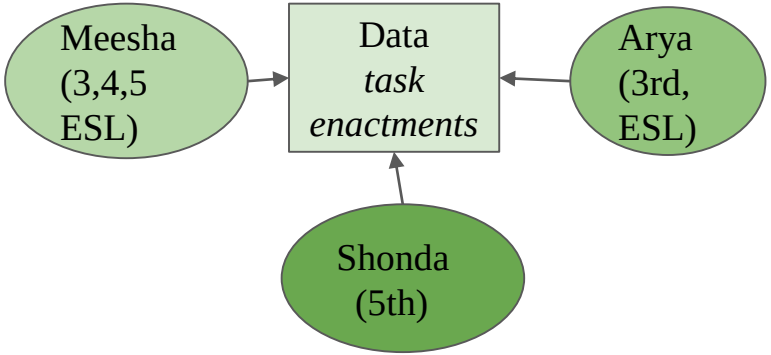
Teachers' Use of Assessment Tasks

Middle School (Grades 6-8)



*Pseudonyms used

Primary School (Grades 3-5)



*Pseudonyms used

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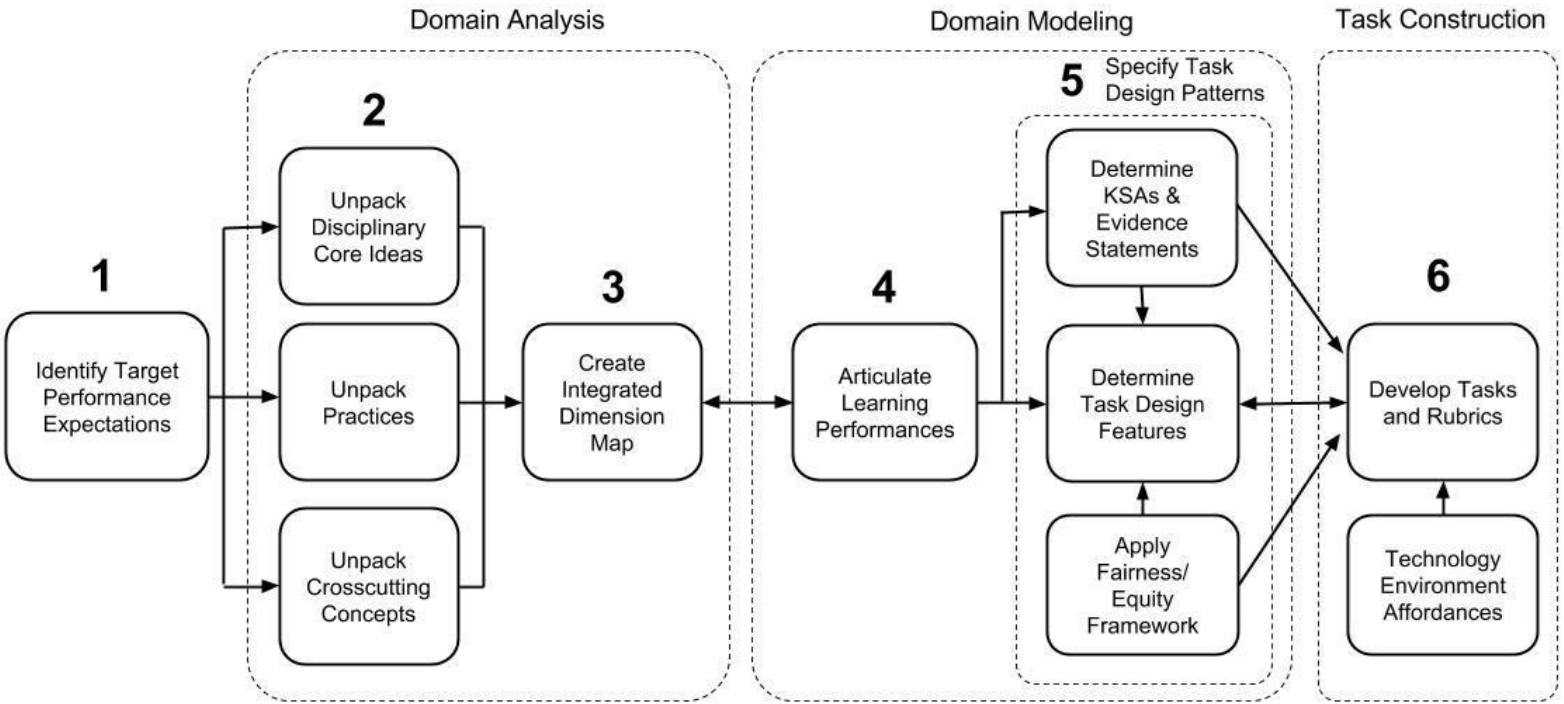
Project funded by the National Science Foundation, grants DRL 1813737 and DRL 1813938.

Designing Instructionally Informative Assessment Tasks



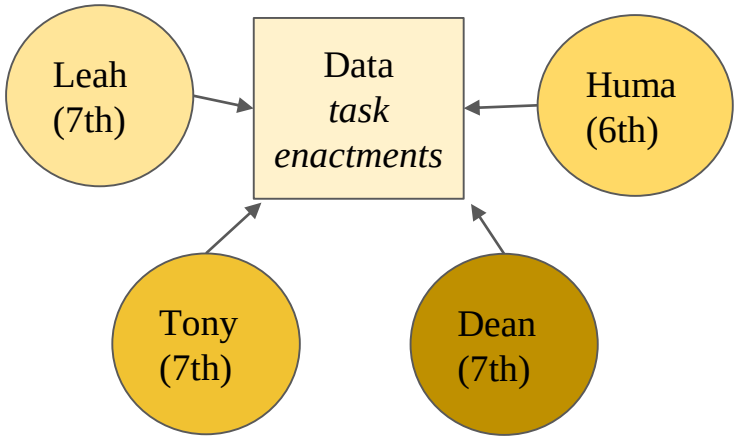
Harris, C. J., Krajcik, J. S., Pellegrino, J. W., & DeBarger, A. H. (2019). Designing knowledge-in-use assessments to promote deeper learning. *Educational measurement: issues and practice*, *38*(2), 53-67.

Middle School Teachers' Task Enactments (Grades 6-8)

Middle School Teachers

Sample: **4 participating teachers**

- Leah, Tony, and Dean taught in the same school district while Huma taught in another school district
- Had been teaching MS for over 5 years
- Had subject matter expertise in science
- Dedicated time in the school day for science
- Were using the same reform-based curriculum for at least 2 years which focuses students on using scientific practices to explore and understand observed phenomenon.
- We offered about 5 hours of professional learning covering topics such as the three-dimensional nature of NGSS, assessment as a process of reasoning from evidence, and using the assessment task portal in their classes.



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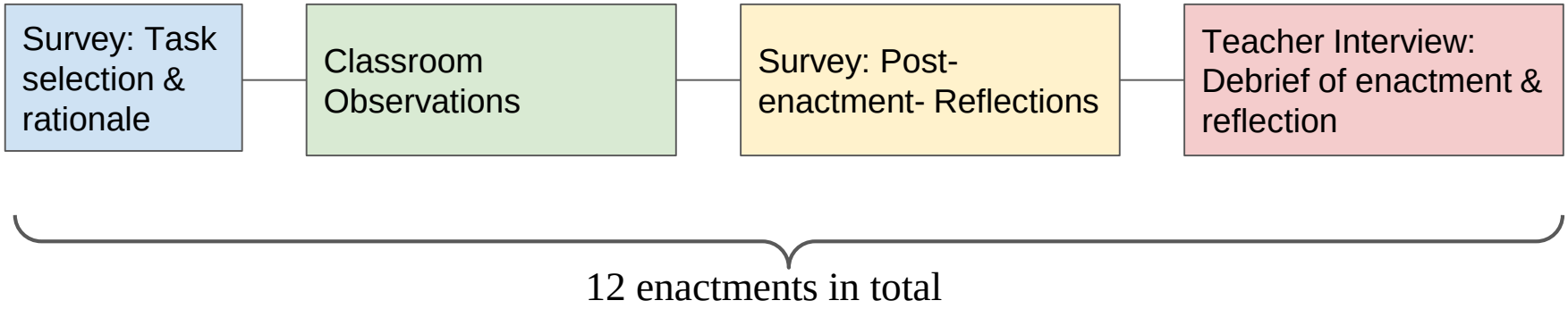
Data Sources & Analysis



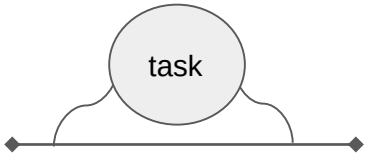
We worked to ensure that interpretations represented the teacher participants' words to preserve the local meaning, as defined by the participant (Erickson, 1986).

For each task enactment we identified the following:

- the purpose of task use,
- how the task was embedded & enacted in the class,
- the next steps for instruction that stemmed from using the task with students.

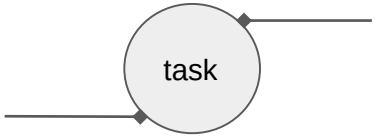
This resulted in 3 unique portraits of task use.

Tasks to Inform Instruction: Portraits of Enactments



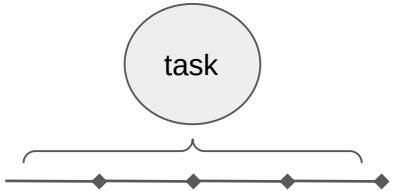
Abstraction

As a **bridge** for students to broaden the disciplinary ideas and practices introduced in immediate curricular context to new scenarios



Stepping-Stone

As a way for students to make **connections** to the disciplinary ideas and practices previously introduced in a unit, and as a **building block** for the development of subsequent disciplinary ideas and practices



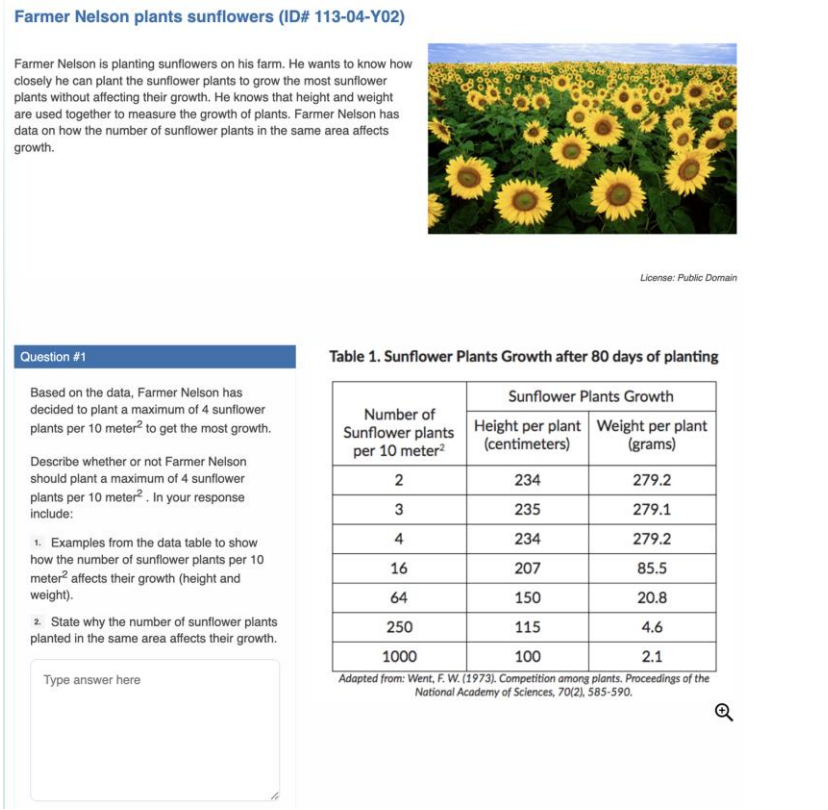
Synthesis

As an opportunity for students to demonstrate their ability to **integrate** numerous disciplinary core ideas and practices from multiple weeks of instruction before moving on to the next unit which builds on these same ideas.

Abstraction

Planning: Huma used this task in a unit where students were learning about how different animals interact within an ecosystem to meet their survival needs.

She stated that “Sometimes students struggle with similar concepts when you change the players. I want to see if they still understand the ideas of competition when it is applied to plants instead of animals.”



Farmer Nelson plants sunflowers (ID# 113-04-Y02)

Farmer Nelson is planting sunflowers on his farm. He wants to know how closely he can plant the sunflower plants to grow the most sunflower plants without affecting their growth. He knows that height and weight are used together to measure the growth of plants. Farmer Nelson has data on how the number of sunflower plants in the same area affects growth.

Question #1

Based on the data, Farmer Nelson has decided to plant a maximum of 4 sunflower plants per 10 meter^2 to get the most growth.

Describe whether or not Farmer Nelson should plant a maximum of 4 sunflower plants per 10 meter^2 . In your response include:

1. Examples from the data table to show how the number of sunflower plants per 10 meter^2 affects their growth (height and weight).
2. State why the number of sunflower plants planted in the same area affects their growth.

Type answer here

Table 1. Sunflower Plants Growth after 80 days of planting

Number of Sunflower plants per 10 meter^2	Sunflower Plants Growth	
	Height per plant (centimeters)	Weight per plant (grams)
2	234	279.2
3	235	279.1
4	234	279.2
16	207	85.5
64	150	20.8
250	115	4.6
1000	100	2.1

Adapted from: Went, F. W. (1973). Competition among plants. Proceedings of the National Academy of Sciences, 70(2), 585-590.

Abstraction

Enactment: Huma clarified to her students that she wanted students to explain why it would or would not be a good idea to plant the sunflowers in one area.

Clarifying and sharing criteria for success

- Students worked on the task individually.
- After students had completed the task, Huma noticed that many students were hesitant to share their answers so she made them do a "pair share" to get them more comfortable with sharing.
- Huma noted that the pair share provided feedback to students and many students went back to edit their response.

Activating students as instructional resources for one another

Activating students as the owners of their own learning;
Providing feedback that moves learners forward

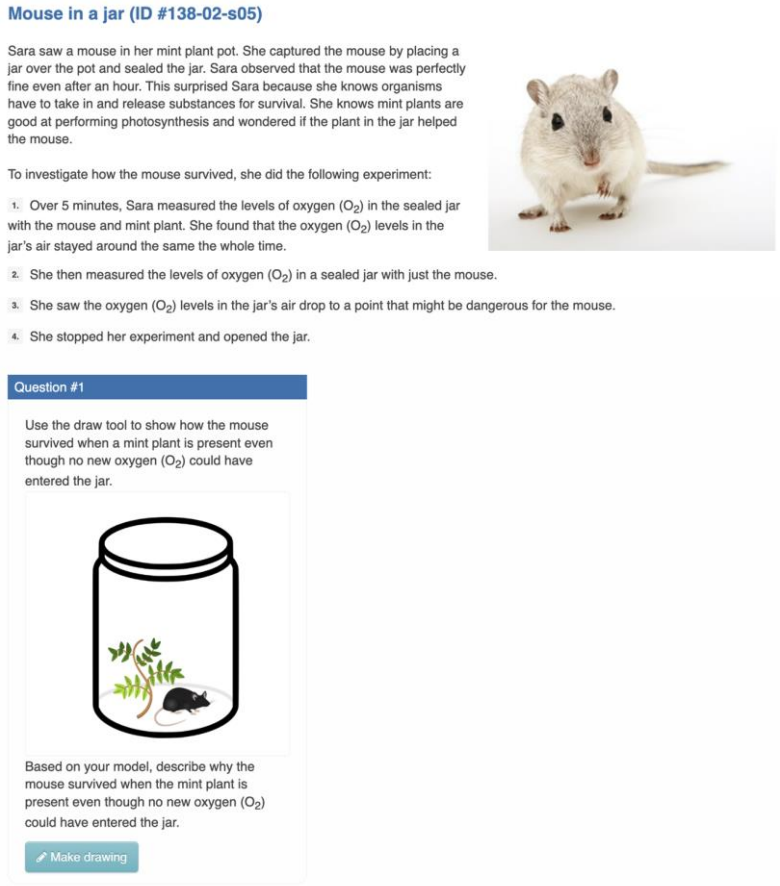
Reflection: Huma noticed that the students found interpreting the table difficult. For the warm-up the next day they talked about how to pull evidence out of the table because she noticed that was a struggle. Huma also recognized the need for more data analysis opportunities in her instruction.

Instructional Adaptation

Stepping Stone

Planning: Leah wanted to use the task as a “tool to assess current understanding of how atoms are cycled between organisms”. That would allow her “ to address any misconceptions before adding to the complexity of this topic.”

After the assessment task, the students were going to read about an important historic experiment using a plant and a mouse (Joseph Priestley). This experiment is more complex than the task, but the task was to provide students with a chance to develop understanding of key ideas around matter cycling.



Mouse in a jar (ID #138-02-s05)

Sara saw a mouse in her mint plant pot. She captured the mouse by placing a jar over the pot and sealed the jar. Sara observed that the mouse was perfectly fine even after an hour. This surprised Sara because she knows organisms have to take in and release substances for survival. She knows mint plants are good at performing photosynthesis and wondered if the plant in the jar helped the mouse.

To investigate how the mouse survived, she did the following experiment:

1. Over 5 minutes, Sara measured the levels of oxygen (O_2) in the sealed jar with the mouse and mint plant. She found that the oxygen (O_2) levels in the jar's air stayed around the same the whole time.
2. She then measured the levels of oxygen (O_2) in a sealed jar with just the mouse.
3. She saw the oxygen (O_2) levels in the jar's air drop to a point that might be dangerous for the mouse.
4. She stopped her experiment and opened the jar.

Question #1

Use the draw tool to show how the mouse survived when a mint plant is present even though no new oxygen (O_2) could have entered the jar.

Based on your model, describe why the mouse survived when the mint plant is present even though no new oxygen (O_2) could have entered the jar.

Make drawing

Stepping Stone

Enactment: Leah went over the task, learning goals and criteria for success with her class.

- Then students worked in small groups to develop their model.
- Leah checked on different groups and shared any student struggles she noticed with the whole class.

This lead Leah to introduce a whole class consensus model that was built by using information from different student groups.

Reflection: Leah said that she heard the students using knowledge gained from prior activities in this unit.

- She heard them engaging in scientific argumentation within their small groups. They were able to use evidence to support their claims.
- They were also helping each other with the drawing tools when trying to draw their models.
- She felt her decision to move to the whole class model helped students develop deeper understanding.

← *Clarifying and sharing learning goals & criteria for success*

← *Activating students as instructional resources for one another*

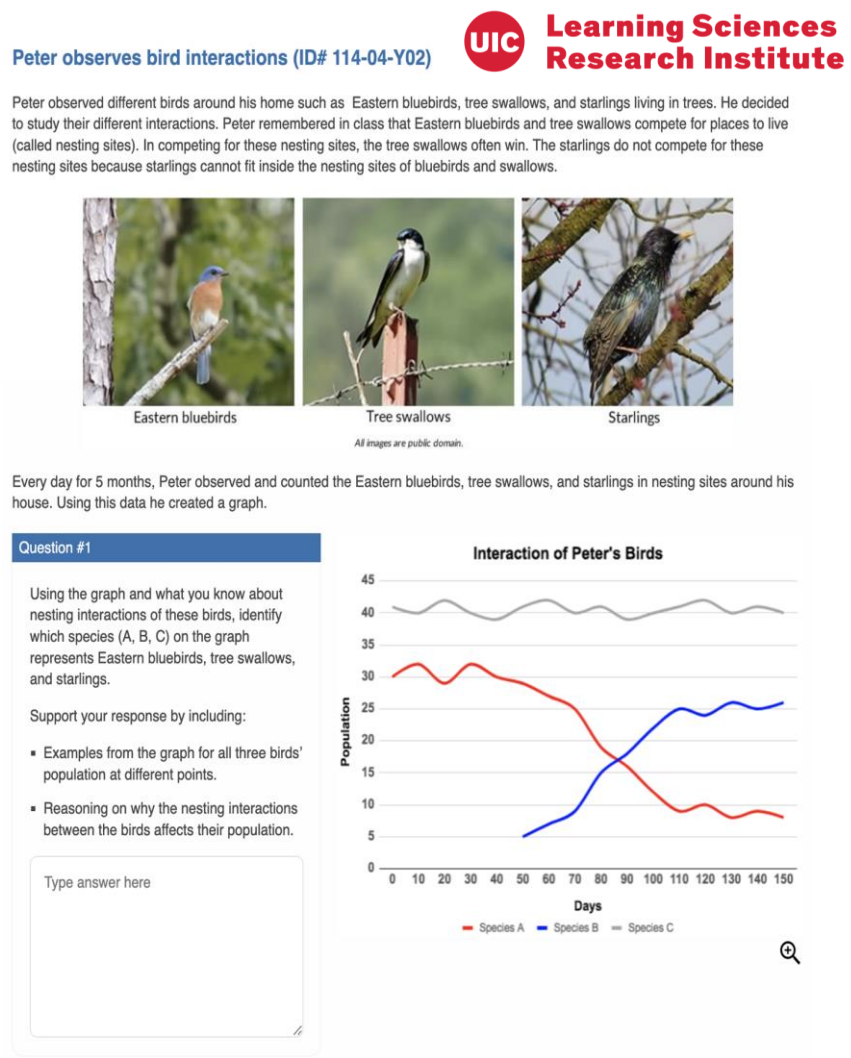
← *Providing feedback that moves learners forward*

← *Instructional Adaptation*

Synthesis

Planning: Tony wanted to use the task as a way to synthesize what students had learned across multiple lessons in a unit about the factors that can impact an organism's population to change.

"I will use this data as a learning point on how they learn the importance of competition and are they bringing all of the important points together in the unit [on factors impacting population changes of organisms] by using the practices of data analysis and supporting claims with evidence."



Synthesis

Enactment: Students read the task out aloud and Tony went over how to read the graph and the legend. He emphasized multiple times on how to use evidence to support the claim and that students were to think about the factors that impact population changes.

- Students then worked in small groups to discuss the task before they responded to the task individually.
- Tony asked multiple students to do a share out of their responses and used the responses to reinforce key ideas and how evidence was being drawn to support the claim.

Reflection : Tony felt that he was able to gauge that students were able to get at how competition was playing a role in population changes.

- Most students had been able to get at the correct answer and were able to use the data appropriately to support the claim.

← *Clarifying and sharing learning goals & criteria for success*

← *Activating students as instructional resources for one another*

← *Activating students as the owners of their own learning;*

← *Providing feedback that moves learners forward*

← *Instructional Adaptation not required*

Primary Grade Teachers' Task Enactments (Grades 3-5)

Primary Grade Teachers (Grades 3-5)

- The teachers were collaborating with us over 4 years on task design and task use, where we provided them professional development on the NGSS, 3-dimensional learning, assessment as a process of reasoning from evidence.
- From our ongoing work with these teachers we learned that these teachers used the *tasks as instruction.*

    - They use it to help provide students opportunity to learn and engage in 3-dimensional learning given they do not have prescribed reform-based curriculum materials.
    - When using our designed tasks in classrooms, we learned that teachers were designing tasks similar to the ones they wanted to assess student learning on so that they could provide students the opportunity to learn being before the assessment.
    - To support these enactments we designed a paired task approach, where the first task could help teachers provide students the opportunity to engage in the learning while they could use the second task to assess student learning.

- In this talk, **I will focus on** the first task, **the task used by teachers as instruction,** since it provided unique enactments for formative use of assessments.

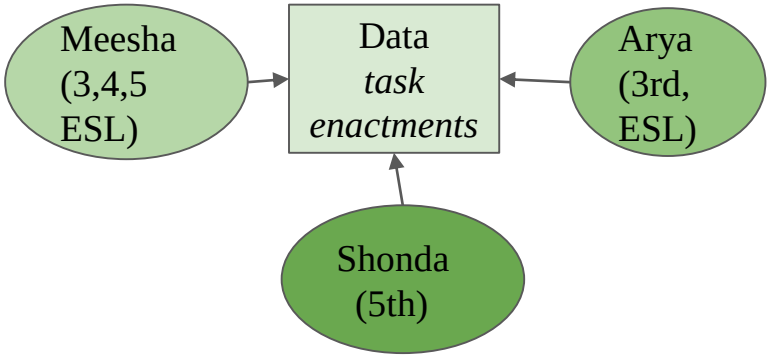
Elementary Grade Teachers

Sample: 3 Participating Teachers

- Meesha, Arya and Shonda were from the same school district
- Had been primary school teachers for over 5 years
- 2 of the three teachers exclusively worked with students who had English as a Second Language (ESL)

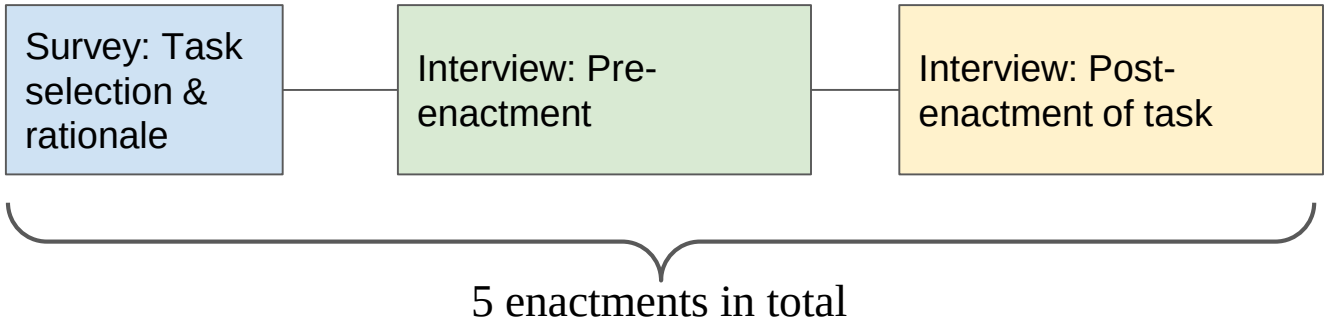
In contrast to Middle School Teachers

- Were generalist where they taught Math, English Language Arts, Social Studies and Science
- Did not have subject matter expertise in science
- Often did not have reserved time in the school day for science (sometimes as little as 15 minutes)
- Teachers were aiming towards the NGSS but did not have prescribed curricular materials.
- Had collaborated with us for over 4 years with 60 hours of professional development.



*Pseudonyms used

Data Sources & Preliminary Analysis



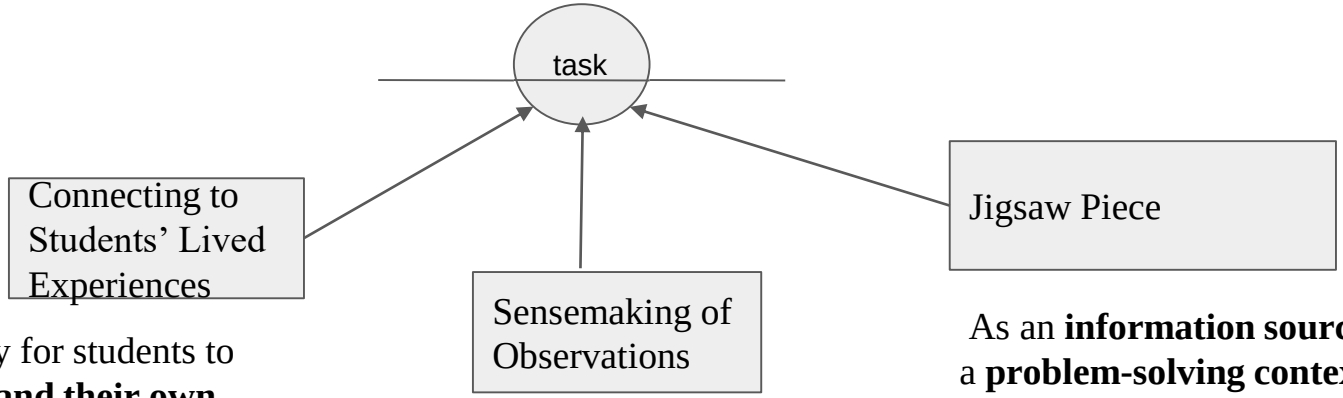
We worked to ensure that interpretations represented the teacher participants' words to preserve the local meaning, as defined by the participant (Erickson, 1986).

For each task enactment we identified the following:

- the purpose of the task use
- how the tasks was embedded & enacted in the class,
- the next steps for instruction that stemmed from using the task with students.

Data collected between May 25, 2022- June 3, 2022. Analysis is ongoing.

Tasks *as* Instruction: Portraits of Enactments



As a way for students to **understand their own experiences** as they engage in disciplinary core ideas, develop familiarity with scientific terminology and develop proficiency on the science practices

As a way for students to **make sense of observations** as they engage in disciplinary core ideas, develop familiarity with scientific terminology, and develop proficiency on the science practices

As an **information source** for a **problem-solving context** as they bring together their disciplinary core ideas, scientific terminology, and science practices.

Connecting to Students' Lived Experiences

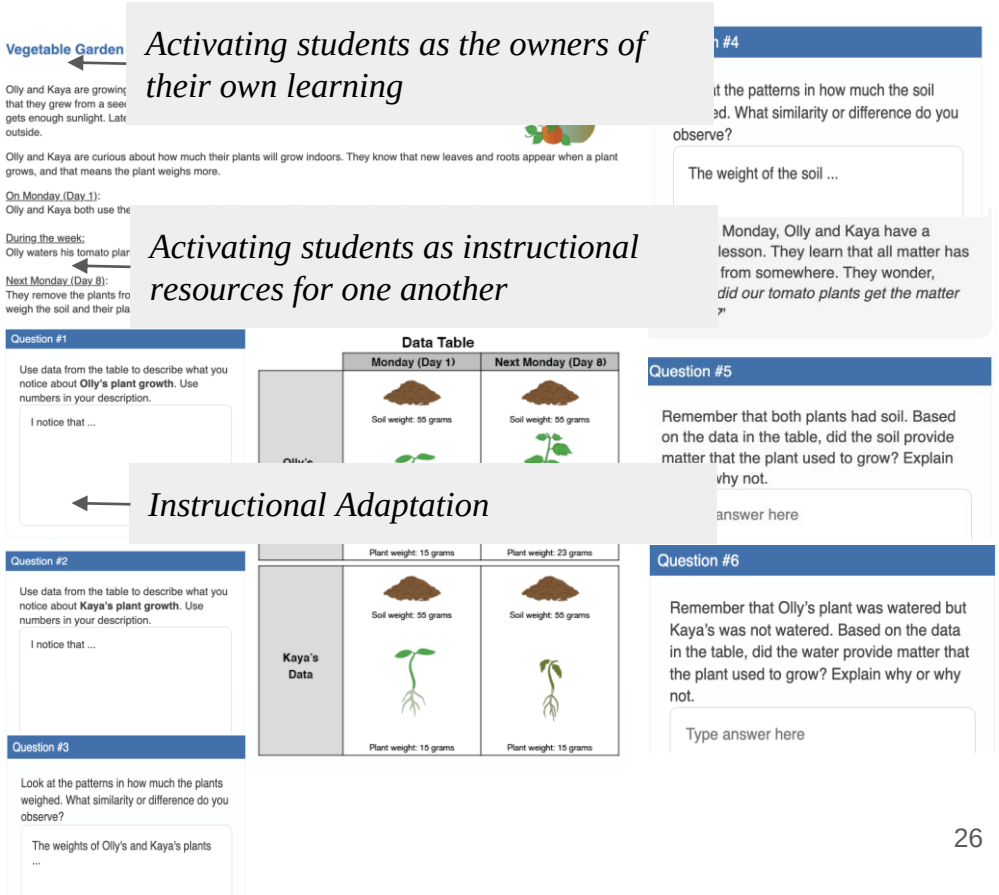
Planning: Meesha wanted to use the task as a way for her 5th grade students to apply the disciplinary ideas of conservation of mass and engage in data analysis while making a connection to students classroom experience of growing tomato plants.

Enactment: The students worked in small groups while working on the task.

- She read read out loud the task as well as pre-recorded her reading the task as well as the questions to provide text-to-speech capabilities for her students.
- Meesha also drew a graph for plant growth to scaffold students thinking about trends in plant weight. This was to help "students in determining a trend and therefore a pattern in the data."

Reflection: Meesha noticed that students did not struggle with water providing the matter for plant growth.

- But they did struggle with what it meant to "look at patterns" and using data to support that water was related to plant growth.
- This is where Meesha spent most of the instruction time, including scaffolds such as graphing the data.



Sensemaking of Observations

Planning: Arya used the task as a way for students to bring ideas they had learned about life cycles, their ability to do comparisons in data and generalize, a practice they were still learning. Arya had students to engage in sense-making around a real world phenomena of a bird's nest in her house. She also mentioned how the spring-summer season allows for students to a lot of observations around plant's life cycles (e.g., plant growth) which they could bring to this task.

Enactment: Arya used the task as a guided activity as a whole group where she reviewed information about life cycles and helped students understand what the prompts were asking them to do.

- This was followed by small group discussion that was connected to the bird's nest.
- Arya also noticed that most students stopped at understanding that the birds just fly away in the end. Few students talked about the new birds starting their own lifecycle
- Arya provided sentence starters to help students with responding to the task.
- Scientific terminology such as "reproduction" was a challenge for students. Arya went over terminology and use of scientific terminology in oral and written discussions was applauded.

Reflection: The verbal responses were much more rich than written responses. Written responses were not the most accurate representation of student learning.

Jigsaw Piece

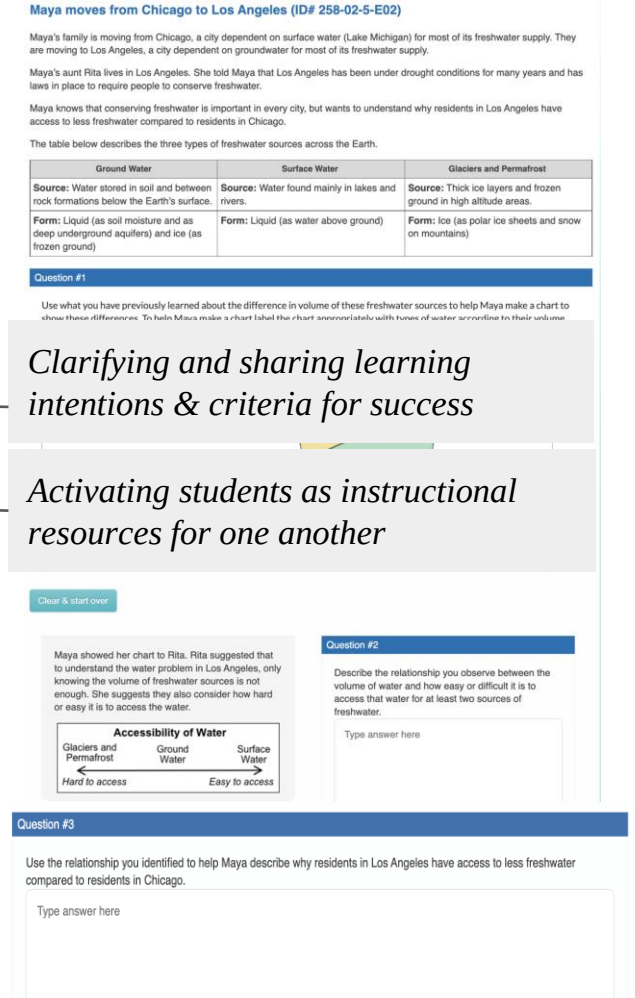
Planning: Shonda was doing a project on deciding upon a place to drill a well. She used this task as an information source for students correlate the relationships between the amount of freshwater available and ease of access

Enactment: Shonda had students look up the the geography of the LA region and discussed different ways of getting water.

- They discussed the connection to the larger project and spoke about what would the water sources be if they had to drill a well in LA.
- Students worked in small groups as they engaged in completing the pie chart and responding to the questions.

Reflection: Shonda noticed that students were able to use scientific terminology such as ground water, run off, water cycle, aquifers, that had been introduced in prior instruction.

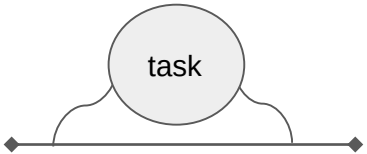
- Shonda, felt that the task went well and that the students were engaged because it helped them with figuring out part of the larger problem-solving challenge.



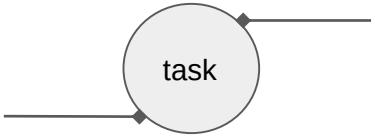
Discussion & Implications

Differences in the Portraits of Enactments

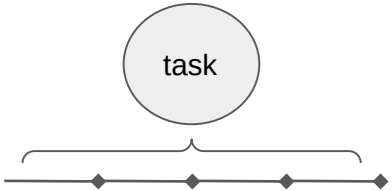
Tasks to Inform Instruction



Abstraction

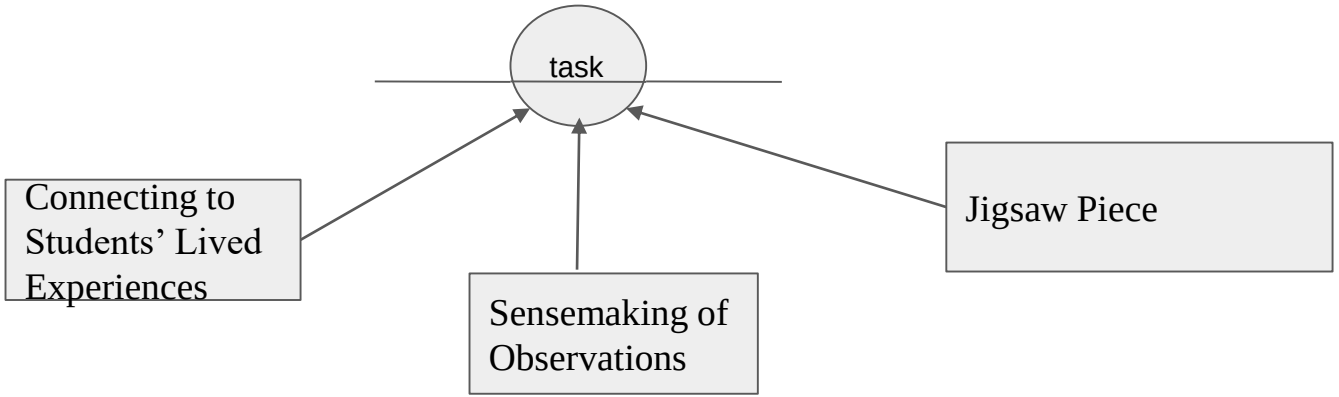


Stepping-Stone



Synthesis

Tasks *as* Instruction



Discussion

I had proposed that illustrating how the practices of formatively assessing fit into teachers' larger instructional schema can help provide all teachers with a more coherent picture of how instruction and formative use of assessments fit together.

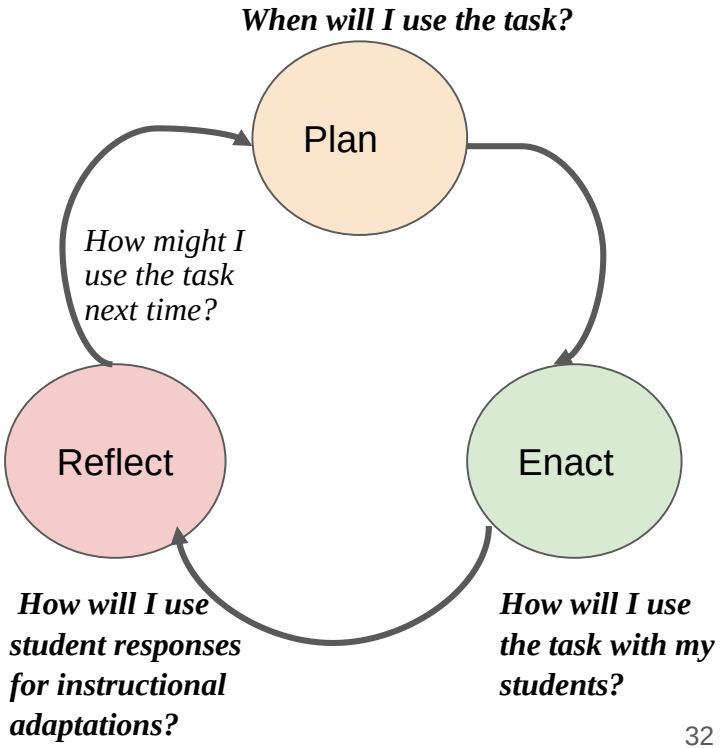
Research Question: *How do teachers use instructionally informative assessment tasks as part of their instructional schema in order to inform their multi-dimensional instruction?*

- Use is based on where students are in their learning and the purpose the task can serve to advance learning and teaching
- Determine what the task measures and what supports or opportunities students have had/will need in order to engage with the task
- Task enactments leveraged teachers instructional practices, including active role of students in learning.
- While all portraits did not use all key strategies (e.g., in many enactments teachers did not clarify learning goals for students) these portraits can be a good starting point for teachers to see how instruction and formative use of the task fit together.

Implications: Supporting Teacher Practice

- We can challenge the perception of formative use of assessments as an “add-on” activity by providing supports for teachers on how to fit assessments into instruction
  - Highlight how the information from assessments can be used to inform instruction
  - Highlight how instructional practices can be leveraged for formative use of assessments

- Can use the idea of Instructional Cycles (Zembal-Saul,Blumenfeld, Krajcik, 2000) to support teacher practice
  - Through resources and/or through professional learning



Design Implications for Instructionally Informative Tasks

Implications for task design that can facilitate use of tasks in instructionally informative ways

1. Scenario is engaging and relevant to students lives
2. Scenario uses real world contexts, published data, historical experiments
3. Task provides students opportunities to engage in science and engineering practices
4. Task provides exposure to academic and scientific terminology (with adequate scaffolding provided)
5. Prompts promote students' sensemaking
6. Prompts enable responses in multiple modalities

Other Considerations:

1. Need for multiple tasks measuring the same construct to help teachers use tasks in different ways or at different time points
2. Educative tools for teachers to help them understand what the task is measuring so that they can establish connections between task and instruction
3. Resources, such as rubrics to facilitate gauging student learning during enactments

Ongoing Resources Development

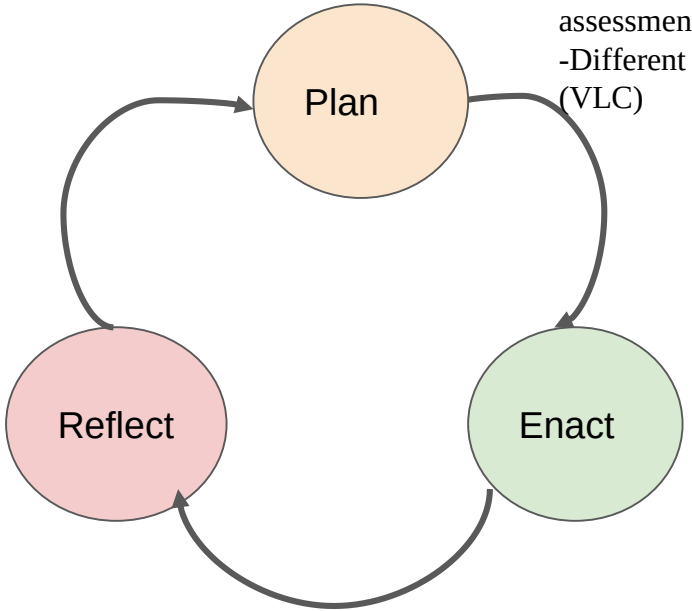
Learning Sciences Research Institute

Next Generation Science Assessment

Scan to preview tasks and join!

-Educative Tool for teachers to understand the NGSS and what the task is measuring
-Videos on linking existing teacher practices to formative use of assessments
-Different ways of using tasks on the Virtual Learning Community (VLC)

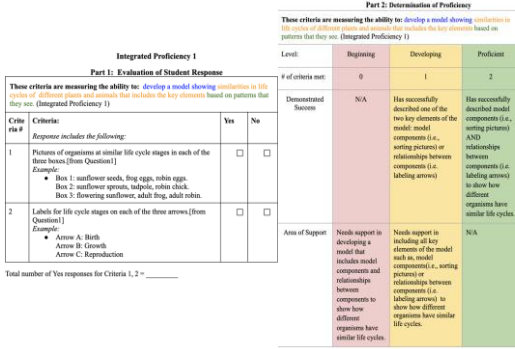
Understanding PROGRESS in Science



Discussion boards

Participate in discussions

Rubrics that facilitate gauging student learning during enactments



Integrated Proficiency 1
Part 1: Evaluation of Student Response

These criteria are measuring the ability to: develop a model showing similarities in life cycles of different plants and animals that includes the key elements based on patterns that they see. (Integrated Proficiency 1)

Criteria #	Criteria: Response includes the following:	Yes	No
1	Pictures of organisms at similar life cycle stages in each of the three boxes.[from Question1] Example: • Box 1: sunflower seeds, frog eggs, robin eggs. Box 2: sunflower sprouts, tadpole, robin chick. Box 3: flowering sunflower, adult frog, adult robin.	☐	☐
2	Labels for life cycle stages on each of the three arrows.[from Question1] Example: • Arrow A: Birth Arrow B: Growth Arrow C: Reproduction	☐	☐

Total number of Yes responses for Criteria 1, 2 = _____

Integrated Proficiency 1
Part 2: Determination of Proficiency

These criteria are measuring the ability to: develop a model showing similarities in life cycles of different plants and animals that includes the key elements based on patterns that they see. (Integrated Proficiency 1)

Level:	Beginning	Developing	Proficient
# of criteria met:	0	1	2
Demonstrated Success	N/A	Has successfully described one of the two key elements of the model: model components (i.e., sorting pictures) or relationships between components (i.e. labeling arrows)	Has successfully described model components (i.e., sorting pictures) AND relationships between components (i.e. labeling arrows) to show how different organisms have similar life cycles.
Area of Support	Needs support in developing a model that includes model components and relationships between components to show how different organisms have similar life cycles.	Needs support in including all key elements of the model such as, model components(i.e., sorting pictures) or relationships between components (i.e. labeling arrows) to show how different organisms have similar life cycles.	N/A

Zaidi, S.Z., Arnold, S., Lehman, E.M., & Strickland, C. (2022). Beyond the design of assessment tasks: Expanding the assessment toolkit to support teachers' formative assessment practices in elementary science classrooms. In Chinn, C., Tan, E., Chan, C., and Kali, Y.(Eds.). International Collaboration toward Educational Innovation for All: Overarching Research, Development, and Practices, Proceedings of the 16th International Conference of the Learning Sciences (ICLS) 2022, 1964-1965. Hiroshima, Japan: International Society of the Learning Sciences.

Selected Presentations & Publications

- Zaidi, S.Z., Ko, M., Gane, B.D., Madden, K., Gaur, D., Pellegrino. J.W. (2018, March). Portraits of teachers using three-dimensional assessment tasks to inform instruction. Paper presented at the 91st NARST Annual International Conference, Atlanta, Georgia.
- Gane,B.D., Zaidi, S.Z., & Pellegrino, J.W. (2018). Measuring what matters: Using technology to enable the assessment of multidimensional learning. *European Journal of Educ*ation, *53*(1), 1-12. https://doi.org/10.1111/ejed.12269
- Zaidi, S.Z., Arnold, S., Lehman, E.M., & Strickland, C. (2022). Beyond the design of assessment tasks: Expanding the assessment toolkit to support teachers' formative assessment practices in elementary science classrooms. In Chinn, C., Tan, E., Chan, C., and Kali, Y.(Eds.). International Collaboration toward Educational Innovation for All: Overarching Research, Development, and Practices, Proceedings of the 16th International Conference of the Learning Sciences (ICLS) 2022, 1964-1965. Hiroshima, Japan: International Society of the Learning Sciences.

Upcoming Presentations & Publications

- Zaidi, S.Z, &Arnold, S. (2022, July). *A rubric design for making sense of elementary students' 3D knowledge and understanding.* Paper presented at the 2022 Annual National Conference of the National Science Teachers Association (NSTA), Chicago, Illinois.
- Gane, B.D, Lehman, E.M., & Zaidi, S.Z (2022, July).M*ultidimensional assessment tasks and a virtual learning community for elementary science teachers.* Paper presented at the 2022 Annual National Conference of the National Science Teachers Association (NSTA), Chicago, Illinois.
- Lehman, E.M., Zaidi, S.Z.,Gane, B.D, & Gaur, D. (2022, July). NGSS-Aligned assessments for formative use in the elementary classroom. Paper presented at the 2022 Annual National Conference of the National Science Teachers Association (NSTA), Chicago, Illinois.
- Zaidi, S.Z., McElhaney, K.W., & Alozie, N. (book proposal accepted). Unpacking and mapping the NGSS dimensions. In Harris, C. J., Krajcik, J. S., & Pellegrino, J. W. (Eds.) *Creating and using instructionally supportive assessments in NGSS classrooms*. NSTA Press.
- Ko, M., Morales, C., & A, Zaidi, S.Z. (book proposal accepted). Using tasks in instructionally supportive ways. In Harris, C. J., Krajcik, J. S., & Pellegrino, J. W. (Eds.) *Creating and using instructionally supportive assessments in NGSS classrooms.* NSTA Press.

Contributions from the Team

Middle School Work

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- Brian Gane(UIC)
- Mon-Lin Ko (UIC)
- Diksha Gaur (UIC)
- Krystal Madden (UIC)
- Joe Krajcik (MSU-Create for STEM)
- Phyllis Haugabook (MSU-Create for STEM)
- Christopher Harris (WestEd)
- Nonye Alozie (SRI International)
- Dan Damelin (Concord Consortium)

Elementary Grades Work

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- Brian Gane(UIC)
- Diksha Gaur (UIC)
- Samuel Arnold (UIC)
- Carla Strickland (UChicago)
- Elizabeth Lehman (UChicago)
- Dan Damelin(Concord Consortium)

References

- Andersson, C., & Palm, T. (2017). The impact of formative assessment on student achievement: A study of the effects of changes to classroom practice after a comprehensive professional development programme. *Learning and Instruction*, *49*, 92-102.
- Banilower, E. R., Smith, P. S., Malzahn, K. A., Plumley, C. L., Gordon, E. M., & Hayes, M. L. (2018). Report of the 2018 NSSME+. *Horizon Research, Inc.*
- Ball, D. L., & Forzani, F. M. (2009). The work of teaching and the challenge for teacher education. *Journal of Teacher Education, 60*(5), 497-511.
- Ball, D. L., & Forzani, F. M. (2011). Building a common core for learning to teach, and connecting professional learning to practice. *American Educator*, *35*(2), 17-21, 38-39.
- Black, P., & Wiliam, D. (1998a). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7-74.
- Black, P., and D. Wiliam. 1998b. Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan* 80, no. 2: 139–48.
- Bishop, R., Berryman, M., Cavanagh, T., & Teddy, L. (2009). Te kotahitanga: Addressing educational disparities facing Maori students in New Zealand. *Teaching and Teacher Education*, *25*(5), 734e742.
- Cisterna, D., & Gotwals, A. W. (2018). Enactment of Ongoing Formative Assessment: Challenges and Opportunities for Professional Development and Practice. *Journal of Science Teacher Education*, *29*(3), 200-222.
- Curriculum Development Council (CDC). (2015*). Overview on Promotion of STEM Education: Unleashing Potential in Innovation*. Hong Kong: Government of Hong Kong (HKSARG).
- Cowie, B. & Bell, B. (1996). Validity and formative assessment in the science classroom, invited keynote paper to Symposium on Validity in Educational Assessment, 28- 30 June, Dunedin, New Zealand.
- Decristan, J., Klieme, E., Kunter, M., Hochweber, J., Buttner, G., Fauth, B., & Hardy, I. (2015). Embedded formative assessment and classroom process quality: How do they interact in promoting science understanding? *American Educational Research Journal*, *52*(6), 1133-1159. https://doi.org/10.3102/0002831215596412

References Contd…

- European Commission. (2012). *Rethinking education*. Retrieved from http://ec.europa.eu.proxy.cc.uic.edu/education/policy/multilingualism/rethinking-education_en
- Education Bureau (EDB). (2016). *Report on Promotion of STEM Education: Unleashing Potential in Innovation*. Hong Kong: Government of Hong Kong (HKSARG).
- Education Bureau (EDB). (2020). *Optimize the Curriculum for the Future and Foster Whole- person Development and Diverse Talents: Task Force on Review of School Curriculum Final Report*. Hong Kong: Government of Hong Kong (HKSARG).
- Hill, M. F., Ell, F., Grudnoff, L., Haigh, M., Cochran-Smith, M., Chang, W. C., & Ludlow, L. (2017). Assessment for equity: Learning how to use evidence to scaffold learning and improve teaching. *Assessment in Education: Principles, Policy & Practice*, *24*(2), 185-204.
- Lee, H., Chung, H. Q., Zhang, Y., Abedi, J., & Warschauer, M. (2020). The effectiveness and features of formative assessment in US K-12 education: A systematic re- view. *Applied Measurement in Education*, *33*(2), 124e140.
- National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.
- NGSS Lead States. (2013). *Next generation science standards: For states, by states*. Washington, DC: The National Academies Press.
- Popham, W.J. 2008. *Transformative assessment.* Alexandria, VA: ASCD.
- Shepard, L.A. 2008. Formative assessment: Caveat emptor. In *The future of assessment: Shaping teaching and learning*, ed. C.A. Dwyer, 279–303. New York: Erlbaum.
- Windschitl, M., Thompson, J., Braaten, M., & Stroupe, D. (2012). The beginner's repertoire: Proposing a core set of instructional practices for teachers of science. *Science Education*, *96*(5), 878-903.
- Zembal-Saul, C., Blumenfeld, P., & Krajcik, J. (2000). Influence of guided cycles of planning, teaching, and reflection on prospective elementary teachers' science content representations. *Journal of Research in Science Teaching*, *37*(4), 318-339.

Thank You

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