

Instructions

"Misconceptions as Barriers to Understanding Science" - National Research Council Link:

<https://nap.nationalacademies.org/read/5287/chapter/5>

"Misconceptions Are 'So Yesterday!'" - PMC Research Article Link:

<https://pmc.ncbi.nlm.nih.gov/articles/PMC3763002/>

"The Relevance of Prior Knowledge in Learning and Instructional Design" Link:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2630138/>

Guiding Questions for Reading:

- What are the different types of misconceptions described in the text?
 - **Preconceived notions:** common conceptions rooted in everyday experiences
 - **Nonscientific beliefs:** views learned by students from religious or mythical teachings
 - Examples: many religions suggest the Earth has only been around for a limited amount of time compared to scientific findings
 - **Conceptual misunderstandings:** students are taught scientific info in a way that doesn't encourage them to confront seemingly self-contradictory statements and conflicts resulting from their own preconceived notions and nonscientific beliefs
 - **Vernacular misconceptions:** when an everyday use word means something different scientifically
 - Example: work
 - **Factual misconceptions:** falsities often learned at an early age and retained unchallenged into adulthood
 - Example: "lightning never strikes twice in one place"
- How do misconceptions differ from simple errors or lack of knowledge?
 - Misconceptions differ from simple errors or lack of knowledge because misconceptions can often seem more reasonable to the learner and can in some way, serve a purpose to the learner, making it more difficult to "correct" than a simple error or lack of knowledge.
- Why is it insufficient to simply "correct" misconceptions through direct instruction?
 - First, misconceptions need to be identified in order to help students confront their misconceptions. One can do this by having them sketch a model of a phenomena or have students have an open, ungraded discussion to see what they think about a

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certain phenomena. To simply explain away misconceptions is not sufficient for students to unlearn misconceptions and learn scientific truths because misconceptions are often deeply rooted and serve a purpose for the individual. Instead of telling a student a scientific truth, showing the student through a demonstration or a lab would be beneficial. The article also talked about students working together to create concept maps.

- National Academies of Sciences, Engineering, and Medicine. 1997. Science Teaching Reconsidered: A Handbook. Washington, DC: The National Academies Press.
<https://doi.org/10.17226/5287>.

Week 6 Assignment

Instructions:

This module explores how to systematically uncover what students are really thinking about STEM concepts and phenomena, moving beyond surface-level responses to understand the reasoning behind student ideas.

Engage in the following and submit via your notes for this week.

Prior Knowledge Self-Assessment:

- Think of a STEM concept you teach that students often struggle with
 - a. Finding volume of a rectangular prism
- List 3-5 ideas students typically bring to this topic
 - a. The formula for finding volume of a rectangular prism is Length x Width x Height: Helpful prior knowledge.
 - b. Volume is similar to area: Helpful prior knowledge and potential misconception.
 - c. Volume and area are the same thing: Problematic misconception.
- Categorize these as: helpful prior knowledge, neutral, or problematic misconceptions
- Reflect: How do you currently address these different types of prior knowledge?
 - a. I support student learning by adding onto this prior knowledge. I do this by having students use connecting cubes to make rectangular prisms and determine the volume by multiplying the base layer (L x W, or area) times the height (H, number

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of layers). This applies to the second idea students typically bring: volume is similar to area.

- b. This can be a potential misconception if they don't understand that area represents the amount of space in a two dimensional space (rectangles are all they have been exposed to up until this point) and volume has the third dimension and third factor being multiplied.

Video Analysis

Watch and Analyze

"Correcting Misconceptions in Science Education" - Understanding Science (Berkeley)

Link: <https://undsci.berkeley.edu/for-educators/prepare-and-plan/correcting-misconceptions/>

Analysis Activity:

- Identify key strategies mentioned for addressing misconceptions
 - Some textbooks perpetuate misconceptions about the nature and process of science. Using the link above to review the textbook and address misconceptions with students is helpful.
 - Clearly defining words, especially scientific words that have alternate meanings in everyday life.
 - I'm not sure what else to add because I could not find a video on the link, just a lot of misconceptions with corrections.
- Note examples that could apply to your teaching context
 - My students this coming school year will have had no prior science learning from school. This will be their first year. However, they may have misconceptions from home. It will be important that I clearly define academic vocabulary words before and throughout lessons so students understand what is being discussed.
 - I noticed I had many of the misconceptions, including:
 - Most scientists are atheists
 - Hypotheses, theories, and laws are interconnected by levels of support
 - Scientists are judged on the basis of how many correct hypotheses they propose.

Reflection Questions:

- Which misconceptions mentioned do you recognize in your students?
 - I have never taught science, so I honestly do not know what misconceptions my students will have; however, I am aware of the misconceptions I had as a child and student, therefore, I will use that information.
 - Science is complete.
 - The process of science does not involve creativity.
 - Science proves ideas.
 - Investigations that don't reach a firm conclusion are useless.
 - The job of a scientist is to find support for their hypothesis.
- How might the strategies suggested change your current approach?
 - If I had been teaching science, I would make sure my students were aware of scientific discoveries that are occurring this decade, not just the past two centuries. I would also help my learners understand and connect that in order to think of a problem to solve or to implement an experiment, one must use their creative thinking. I would also explain to my learners that science accepts or rejects ideas based on evidence, not proof. Additionally, I would help my learners understand that regardless of whether or not one's hypothesis was supported by the evidence, the scientist/learner made a valuable contribution to science.

Formative Assessment Probes

Explore Free Resources for Understanding Student Misconceptions

Main Resources:

- **National Academies Chapter on Misconceptions**
 - **Link:** <https://nap.nationalacademies.org/read/5287/chapter/5>
 - This comprehensive chapter explains how "misconceptions can be uncovered by asking students to sketch or describe some object or phenomenon" and provides strategies for addressing student preconceptions
 - See notes at the beginning of this document.
- **Wisconsin Department of Public Instruction - Science Assessment Examples**

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- **Link:** <https://dpi.wi.gov/science/assessment/examples>
- Includes information about formative assessment probes and notes that "Paige Keeley has a series of books on formative assessment probes" with explanations of how they work.
- **Contextus** - has a wide range of learning modules, articles, and resources on effective science assessment. They also **have a spreadsheet** that links to loads of quality assessments (it hosted on [this page](#), if needed).
- The **Stanford NGSS Assessment Project (SNAP)** is still underway but already has several **examples of performance tasks** across different content areas.
- How to **create** 3D Formative assessments
- How to **create** performance tasks
- **Common misconceptions** by science category

Talk Moves and Questioning Strategies

Talk Science Primer

Link: http://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

Focus on pages 11-15: "Productive Talk Moves"

- Goal 1: help individuals share, expand, and clarify thoughts
 - Students need to be able to share their thinking aloud in an understandable way
- Goal 2: help students listen carefully
 - Students need to try to understand what their peers are saying
- Goal 3: help students deepen reasoning
 - Teacher should press students for reasoning and evidence
- Goal 4: help students engage with others' reasoning
 - Involves students responding to the students ideas and reasoning
- Talk moves:
 - Goal 1: help individuals share, expand, and clarify thoughts
 - Think time:
 - Partner talk
 - Writing as think time
 - Wait time

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- Say more:
 - “Can you say more about that...”, “what do you mean by that?”, “can you give an example?”
- So, are you saying...?
 - “So, let me see if I’ve got what you’re saying. Are you saying...?”
(always leaving space for the original student to agree or disagree and say more)
- Goal 2: help students listen carefully
 - Who can rephrase or repeat?
 - “Who can repeat what Javon just said or put it into their own words?”
(After a partner talk) “What did your partner say?”
- Goal 3: help students deepen reasoning
 - Asking for evidence or reasoning
 - “Why do you think that?”
 - “What’s your evidence?”
 - “How did you arrive at that conclusion?”
 - “Is there anything in the text that made you think that?”
 - Challenge or counterexample:
 - “Does it always work that way?”
 - “How does that idea square with Sonja’s example”
 - “What if it had been a copper cube instead?”
- Goal 4: help students engage with others’ reasoning
 - Agree/Disagree and why
 - “Do you agree/disagree? (And why?)”
 - “Are you saying the same thing as Jelya or something different, and if it’s different, how is it different?”
 - “What do people think about what Vannia said?”
 - “Does anyone want to respond to that idea?”
 - Add-on:
 - “Who can add on to the idea that Jamal is building?”
 - “Can anyone take that suggestion and push it a little bit further?”
 - Explain what someone else means:
 - “Who can explain what she means when she says that?”

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- "Who thinks they can explain in their own words how they think he came up with that answer?"
- "Why do you think he said that?"
- The last 2 pages (14-15) talked about a 4th grade teacher who used talk moves in her science class to get her students more actively engaged and participating in classroom discussions.

Question Development

Transform traditional questions into ones that elicit thinking:

Traditional Question → Thinking-Eliciting Question

- "What is photosynthesis?" → "What do you think plants need to survive and grow?"
- "Define force" → "When you push this cart, what makes it move faster or slower?"
- "What's the formula for area?" → "How could we figure out how much carpet we need for this classroom?"

Create 3 question transformations for your subject area.

- What is motion? → What causes motion?
- What is the difference between recessive and dominant traits? → How can parents pass down some characteristics to their offspring and not others?
- What is the formula for volume? → How could we figure out how many textbooks we can fit inside a desk?

Inclusive Practices Research

Required Reading

"Formative Assessment for Equitable Learning" - NSTA Link:

<https://www.nsta.org/science-teacher/science-teacher-novemberdecember-2021/formative-assessment-equitable-learning>

This article was only available for members.

Focus Areas While Reading:

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- How can formative assessment promote equity?
- What barriers might prevent some students from sharing their ideas?
- How can we make thinking visible for all students?