## Effective Instruction in Science- MPIES

The following elements of effective instruction are derived largely from the learning theory described in the National Research Council's volumes *How People Learn* (2003) and *How Students Learn: Science in the Classroom* (2005).

What Does Effective Instruction Look Like in the Classroom? There are multiple ways each critical element can be incorporated into instruction. Not all five need to occur in every lesson, but rather they may play out over a series of lessons.

What are the Elements of Effective Science Instruction (MPIES)?

- **M**otivation
- Eliciting students' **p**rior knowledge
- **I**ntellectual engagement
- Use of **E**vidence to Make and Critique Claims
- **S**ense-making

**Motivation**

- However well-designed the instruction, students are unlikely to learn if they do not have a desire to do so.
- Instruction needs to "hook" students by addressing something they have wondered about, or can be induced to wonder about, possibly, but not necessarily, in a real-world context.

What Does **Motivation** Look Like in the Classroom?

- Extrinsic motivators- deadlines for research projects, classroom competitions, and tests and quizzes affecting students' grades
- Intrinsic motivators- usually stem from intellectual curiosity and a desire to learn.

**Eliciting Students' Prior Knowledge**

- Research has shown convincingly that students do not come to school as empty vessels; rather, they come with ideas they have gleaned from books, TV, movies, and real-life experiences.
- These ideas may either facilitate or impede their learning of important ideas in science.
- There is considerable evidence that instruction is most effective when it elicits students' initial ideas, provides them with opportunities to confront those ideas, helps them formulate new ideas based on the evidence, and encourages them to reflect upon how their ideas have evolved.

What Does **Eliciting Students' Prior Knowledge** Look Like in the Classroom?

- KWL charts: What students know about a certain concept (K), what they want to know (W), and finally what they have learned (L) by the end of a lesson or unit
- Demonstration of initial ideas using drawings, concept maps, or cartoons.
- Teacher questions
- Encouraging students to raise questions of their own allows teachers to access their existing ideas

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**Intellectual Engagement**

- Research on learning suggests that the hallmark of effective lessons is that they include meaningful experiences that engage students intellectually with important science content.
- Lessons need to engage students in doing the intellectual work, and make sure that the intellectual work is focused on the learning goal.
- When observing classroom instruction, it's helpful to ask yourself, "If I were a student in this class, what would I be thinking about?"

What Does **Intellectual Engagement** Look Like in the Classroom?

- Students have opportunities to engage with appropriate phenomena while investigating meaningful questions.
- Can be through a hands-on experience
- Can be through an interactive lecture (Socratic discussion)

**Use of Evidence to Make and Critique Claims**

- Being scientifically literate requires understanding both scientific ideas and the nature of the scientific enterprise. Students should be encouraged to view science as a process by which knowledge is constructed, not as a collection of facts.
- An integral part of the scientific process is the collection and interpretation of data, which is then used to critique claims and see if they are supported by the evidence.
- Students are less likely to revert to their prior incorrect ideas if they are familiar with the evidence that confronts those ideas and supports the scientific consensus.

What does **Use of Evidence to Make and Critique Claims** Look Like in the Classroom?

- Students should use evidence to support and critique conclusions (both their own and other people's).
- Evidence can come from a hands-on activity, examples from their own life, or data they are given and asked to analyze.
- Drawing appropriate conclusions from data also requires students to have confidence that the data are valid.
- Consequently, discrepancies or conflicting data need to be resolved.
- In some cases, teachers can explain an idea and describe how scientists came to that conclusion.

**Sense-Making**

- Effective science instruction requires opportunities for students to make sense of the ideas with which they have been engaged:
- Making connections between what they did in a lesson and what they were intended to learn.
- Connecting the new ideas to knowledge that students already have, placing the lesson's learning goals in a larger scientific framework and helping students organize their knowledge.

What does **Sense-Making** Look Like in the Classroom?

Sense-making can occur in a number of ways, for example:

- Whole class discussion with appropriate teacher questioning;
- Written student reflection using well-designed, guiding prompts, e.g., considering how, and why, their thinking has changed; or
- Application of ideas to other contexts.

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