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Supporting Student Scientists Writing in Their Scientist Notebook

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What is the Joy in Doing Science?

- Oh! Aha! Eureka! Wow! I never thought of it that way!
- Coming to know or understand something new…self-realization.
- Either wrong old idea, or completely new experience.

- How could we remember it?

Remembering

- Memory is a construction based on expectations.
- Wrong expectations, or no expectations makes memory suspect.
  - Being wrong is an opportunity to learn.
- Scientists and other reflective people keep an intellectual diary:

The Scientist Notebook

Not a New Idea

St. Augustine (300 AD)

- Reason says: Suppose you discovered some truth. To whom will you entrust it so that you can proceed to further thought?

- Augustine: To my memory I suppose.
- Reason: Can your memory really preserve all your thoughts?
- Augustine: That would be difficult, actually impossible.

- Reason: Then you must write it down.

Educational Practices Can Rob Students of this Joy of Learning

- "Efficiency"
  - Not enough time to cover it all, so we tell them what they should memorize.
  - No longer experience the joy of learning for themselves.
- "Test more and they will learn more"
  - Standardized tests create stress and inhibit playful learning.

Context

- Classroom environment where students learn as scientists do.
- Grade appropriate notebook.
- Notebook becomes concrete evidence of students own work and learning.
- Give students responsibility for their notebook and their learning.

"This is mine, I did it"

Scientist's Notebook

- Notebooks can be:
  - A record of classroom lecture notes
  - A summary of readings
  - A journal for reflecting
  - A planning tool
  - A log of observations or data
- Scientist's Notebook is all of these.

Student Scientist Notebook

- Diary of all work done
  - Ideas, plans, designs, observations, reflections on patterns, individual and group thoughts on the meaning of the results...
- Private and Public Parts
  - Private, what the student writes as the work is being done.
  - Public, what the student writes as the work is discussed by the whole class.

Making It Happen in Your Classroom

1. Repeated classroom use of a notebook strategy.
2. Making time in lesson for writing.
3. Prompts and questions to encourage writing.
4. Classroom activities that highlight and elevate the notebook.
5. Appropriate ongoing assessment.

Indiana Science Initiative
Notebook Strategy for Investigations.

Engage to Generate interest : Private

- Focus Question – Guides toward a standard
- Predict – I think... because....
- Plan – What shall we do to answer the question?

Investigate to Answer the Question : Private

- Data: What we actually did, observations, and measurements.
- Initial response to focus question.
- Claims/Evidence – So what happened; what is the evidence?

Making Meaning Conference: Whole Class Conversation : Public

How we do make sense of our results; what have we learned?

- Revised response to Focus Questions
- Conclusions
- Other questions

Times for Writing

- Before the investigation (Engage)
  - Record the focus question
  - Write predictions, very important
  - Brainstorm planning
- During (Investigate)
  - Describe what was done
  - Record data
  - Small group answer to focus question
- After (Making Meaning)
  - What have we learned
  - Whole group answer to focus question
  - New questions

Making Time

- Strategies depend on
  - Grade level, class character.
- Stop and Go
  - Stop work.
  - Remove distractions.
  - Students write.
  - Quiet time…you assess and think.
- Evolve toward continuous writing.

Prompts keyed to Notebook Strategy

- Engage
  - I predict that….because
  - The steps to our plan are…
  - The things I will measure are…
- Investigate
  - To answer the question we…
  - I think… because…
  - I claim… because…
- Making Meaning
  - I think my prediction was…because…
  - Our class decided…because…

Explain your reasoning

Questions Should be Productive

- They invite discussion of ideas.
  - Multiple answers are possible
- Not a simple yes or no answer.
- Questions are based on the experiences of students, not on information from teacher or textbook.
- Questions invite students to explain their thinking.

Productive question keeps focus on student, not on teacher.

Productive vs. Unproductive

Productive	Unproductive
Supports purpose of stage of inquiry	Tangential or unrelated to purpose of stages of inquiry
Relates to science understanding from investigations	Repetition of facts from resource, book, teacher
Based on common experience from investigations	Asks students to reason about something not yet experienced
Needs more explanation than Yes/No or Right/Wrong	Yes/No or Right/Wrong
Focused on ideas	Focused on vocabulary
Promote activity, thinking and reasoning	Asks students to “parrot back” facts
Focuses on students and student work	Focuses on teacher explanation

Questions Keyed to Notebook Strategy

- Engage
  - Did you notice when…?
  - Can you think of an example of…?
  - What do you think will happen if…?
- Investigate
  - What are you going to investigate?
  - What will you measure?
  - Do you see any patterns in the results?
  - What claims can you make?
- Making Meaning
  - What evidence supports your claim?
  - Do you agree or disagree with…, why?
  - What do you think now, why?

Make Notebook Valuable

- You model by keeping your own notebook about lessons.
- Do not ask students to recall, ask them to read or show from their notebook.
- Make the notebook the primary tool for the Making Meaning Conference.
- Allow students to project their notebook pages as they talk about them.
- Take pictures of good pages and post them for all to see.

Evaluating the Notebook
Keyed to Notebook Strategy

- Engage and Investigate – Private Science
  - Evaluate the format, not the content.
    - Is there a focus question, prediction, description of the work done, etc. Create a simple rubric.
- Making Meaning – Public Science
  - Ask students to draw a dark line below the last thing they wrote in the investigation section.
  - Evaluate below the line for content since it should reflect the whole group conversation, guided by the teacher.
- Collect notebooks opened to the page to be evaluated.

A Working Document

- Just like a scientist, the student scientist learns by working in the notebook.

Richard Feynman in a interview about his notebooks:

- Interviewer: And so this represents the record of the day-to-day work.
- Feynman: I actually did the work on the paper.
- Interviewer: That's right. It wasn't a record of what you had done but it was the work.
- Feynman: It's the doing it – it's the scrap paper.
- Interviewer: Well, the work was done in your head but the record of it is still here.
- Feynman: No, it's not a record, not really, it's working. You have to work on paper and this is the paper. OK?
- Interviewer: OK

Consistent with Frameworks of the Next Generation Science Standards

1) Asking questions (for science) and defining problems (for engineering)
2) Developing and using models
3) Planning and carrying out investigations
4) Analyzing and interpreting data
5) Using mathematics and computational thinking
6) Constructing explanations (for science) and designing solutions (for engineering)
7) Engaging in argument from evidence
8) Obtaining, evaluating, and communicating information

Consistent with Indiana Process Standards

- Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations and communicating their findings. These principles should guide student work and be integrated into the curriculum along with the content standards on a daily basis.

- Make predictions and formulate testable questions.
- Design a fair test.
- Plan and carry out investigations as a class, in small groups or independently, often over a period of several class lessons.
- Perform investigations using appropriate tools and technology that will extend the senses.
- Use measurement skills and apply appropriate units when collecting data.
- Test predictions with multiple trials.
- Keep accurate records in a notebook during investigations and communicate findings to others using graphs, charts, maps and models through oral and written reports.
- Identify simple patterns in data and propose explanations to account for the patterns.
- Compare the results of an investigation with the prediction.

Please Make the Effort

- This takes work and persistence on your part. Work into it gradually.
- Give your students the joy of learning with your guidance.
- In K-8 consider the Indiana Science Initiative (ISI) see Indianascience.org.
- In HS, consider the modeling curriculum. See modeling@asu.

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