Using Sense-making Notebooks: Fostering Student Thinking

(Editor’s note: This article is fourth in a series on notebooks. In previous articles, we discussed links between student and scientists/mathematicians’ notebooks, notebook prompts that strengthen student inquiry abilities such as gathering and interpreting data, and notebook entries that provide windows into student thinking.

In this article, we focus on how teachers can design learning experiences that provide students with opportunities to develop and communicate their conceptual understanding in science.)

Opportunities to Learn

Through the years, our work with notebooks revealed three areas that contribute to increased student understanding: opportunities to learn science content, opportunities for metacognition, and opportunities to improve communication. Our challenge is to make notebook entries student-driven (rather than teacher-directed).

By asking students to record their thinking, teachers are asking them to do much more than simply reflect on the activity – they are asking their students to reflect on their thought processes and how they came to their way of thinking, to use data collected as evidence to support or change ideas about concepts and to share questions they now have.” (Science Notebooks: Writing About Inquiry, Campbell and Fulton, 2003 p. 39).

One way to help students use notebooks purposefully is to analyze student work to determine appropriate scaffolds for content, metacognition and communication. Based on this analysis, teacher interventions may target one or more of these areas.

Here are two examples of teachers who carefully interpreted student work to provide scaffolded learning activities for students to record their thinking.

Example from the Field: Exploring with Electricity

Jana, a fourth grade teacher in Coachella Valley Unified School District, uses notebooks for two main reasons: 1) students collect various kinds of data such as sketches, observations, and quantitative data; and, 2) they write in their notebook to summarize the big idea, their thoughts into words and allowed students to share their ideas orally before committing them to paper.

In addition, during the rebuilding of circuits, I targeted the students I thought might be having language and/or metacognitive issues. I asked them a lot of ‘how’ and ‘why’ questions: ‘Why does that happen?’ ‘How do you know that?’ Eventually, students figured out it could work if they had another wire to make the connection.

“Second, we practiced in small groups. Students used white boards to draw a complete circuit and describe in words the path that the electric current takes. These small group discussions helped students put thoughts into words and allowed students to share their ideas orally before committing them to paper. Third, I modeled how I would answer the question ‘Why is a complete path necessary?’ by doing a think aloud.”

Finally, I had my students answer the same question in their journals, in their words.”

Gloria is now able to communicate in greater detail, both in non-text and words, her understanding of how electricity flows to light a bulb. She even writes a complex sentence in her second statement!

By scaffolding learning activities that allowed students to experience the science content a second time, and orally practice putting their thoughts together before entering them into their notebooks, Jana provided the opportunity and reflection for students to demonstrate their thinking.

Jana learned about a new general student misconception by engaging her students in this activity. She will approach this topic differently in the future: “I will have the students build the circuit many different ways before I give the first assessment,” she explains. “Then I will focus on language or metacognition in the follow-up activities.”

Example from the Field: Exploring with Light

Leslie, a third grade teacher at Montebello Unified School District, uses science notebooks for a variety for reasons. “I want students to be scientists, to...

The text reads: "It won't work because it is not a complete circuit the light bulb will not touch the battery."

Jana noted Gloria’s content misconception – a light bulb literally has to touch a battery to work, instead of knowing that touching the bulb to the battery was just one way to make a connection and a complete circuit. In order to determine how prevalent Gloria’s misconception was among the entire class, Jana engaged students in a think-pair-share. They were asked to discuss if every bulb they used had to touch a battery to be lit. Much to Jana’s surprise, the overwhelming majority of students responded, “Yes!”

Gloria’s second attempt in drawing a diagram and explaining the path of electricity to light a bulb is shown below in Fig. 2.

The light bulb will not work because the wire is not connected. The electricity is incomplete.

Gloria was able to communicate in greater detail, both in non-text and words, her understanding of how electricity flows to light a bulb. She even writes a complex sentence in her second statement! By scaffolding learning activities that allowed students to experience the science content a second time, and orally practice putting their thoughts together before entering them into their notebooks, Jana provided the opportunity and reflection for students to demonstrate their thinking.

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Farewell to a Great Soul

BY KATHY DIRANNA

A great soul serves everyone all the time
A great soul never dies

One great soul, Evaline Athena Assad Khawst McFarlane Kruse died on December 20, 2009. After 89 active years on this earth, she passed quietly and is now at peace.

Though her 35 years of teaching junior high English, Evaline touched thousands of students encouraging them to be the best they could, challenging them academically and personally to aim high. She impacted intercity awareness (long before it was fashionable) in the Los Angeles Unified School District with “Hands Across the District,” a program that brought ethnically and culturally diverse junior high students together for learning, laughter and celebration. In 1985, she was awarded the California Teacher of the Year for her outstanding service to education.

Evaline touched every last breath…for you see, she was my mother. She gave my siblings and I many lessons we try to use throughout our lives. Here are just a few my sister shared at mom’s service:

- Be good at what you do. Never settle for less than you are capable of.
- Be good to others and care about them.
- Sometimes really bad and sad things happen to good people.

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think like scientists, to go through some of the same processes a scientist goes through, and to have a collection of work that they can refer to and remember later on,” she says.

Leslie uses science notebooks to check for student understanding of science-concepts and sometimes for assessment. Analyzing student work is a two-step process, she says.

First, Leslie examines student’s work to identify what students know and don’t know. “When I look at student work, I ask myself. What is it in their work that shows me they understand it? What are their misconceptions? Is it a common misconception? Is it a science misunderstanding or a language one?” she explains.

In the second step, Leslie evaluates students’ work to make decisions about instruction, intervention and assessments. “When I analyze student work, I analyze my teaching,” she says.

“What went wrong? How can I make it better? What are my next steps to help them with their understanding of the concept?”

Fig. 3 and Fig. 4 are examples of student notebook entries that shows what Leslie did to change this student’s conceptual thinking about how light travels. The process illustrates the kind of language support the student needed to communicate her new knowledge about how light travels in a straight line and can be reflected with a mirror.

In the first lesson, students shined a flashlight on several objects, including a mirror. Students were asked to illustrate their experiment and describe the path of the light. See student Karen’s drawing and written description. (Fig. 3).

Karen’s inconsistencies in her diagram demonstrate her conceptual misunderstanding. In addition, Karen’s entry reads more like the experimental procedure, rather than her ideas on what she learned from shining light on different objects. After examining Karen’s notebook entry, Leslie decided to provide students two additional learning activities. Leslie suspected that students needed an additional content exploration to clarify their understanding about light, as well as a language scaffold to help students put thoughts into words – a sentence frame. A sentence frame not only provides the content, but also the structure of the expressed thought.

The next day, students took their mirrors outside and directed the sunlight to reflect off the mirrors and hit the wall of the building. Thereafter, students, with partners, used a sentence frame (see below) to orally share what they had observed to each other.

The ___ travels in a ___ to the mirror. The ___ hits the mirror, changes direction and travels in a ___ to the wall.

The sentence frame provided students a temporary language scaffold and lowered the language demand placed on students, allowing them to focus on learning the content.

Back in the classroom, students used a flashlight and mirror to make the light reflect off of the mirror and hit an index card. According to Leslie, “Then the students went crazy reflecting light to the ceiling, to a specific object, to the ground, inside of their desks…” Each time they used the sentence frame, shown below, with a partner to orally share what they were doing.

The light ___ (beams or rays) ___ from the ___ travel in a ___ to the ___ mirror, ___ the ___ mirror, changes ___ and ___ in ___ to ___ wall.

After exploring with sunlight, a flashlight, a mirror and various other objects, Karen’s drawing is accurate and her written explanation is clearer, as

NOTEBOOKS, CONTINUED ON PAGE 4
Bringing Wonder to Classrooms

Take a walk down the hallways at Daniel Phelan School in Whittier and you will hear and see science come to life. Fourth graders in Buffie Clagis’s class are squirming with delight as they discover how light bulb teamwork, Wendy Fournats’ students are carefully adding plants to terrariums full of fish as they observe “environmental factors.”

Further down the hall, fifth grade teacher Antho- ny Granado is prompting his students to make claims and provide evidence from a recent explore that involved swinging short and long string pendulums. And in kindergarten, Vanessa Apodaca instructs little carpenters to record in their science notebooks how playwooded in made.

So how do these teachers learn how to present stimulating hands on, grade appropriate science to their classes?

It’s time to point the finger and applaud fellow teacher Pat Smith who has worked hard with a science cadre to develop curriculum for the Whitter City School District (WCSD). “Science will always be a source of wonder; as it brings out ‘the kid in all of us,’” says Pat who was nominated in 1997 for the President Science Teachers Award and was recent- ly honored as Teacher of the Year by the Youth Science Center of the San Gabriel Valley.

Pat’s road to teaching at WCSD began in 1998 when she received a three-year grant to pro- mote inquiry-based, hands-on science from the Na- tional Science Foundation. CAPSI (Caltech) and Pas-adena Unified City School District. As the school district Program Coordinator for SEARC (Science Education Actively Realized in Children’s Hands), Pat worked with district teachers to develop a kit-based program in WCSD that net- works with Caltech scientists and their community.

After the WCSD adopted the FOSS science units last year, Pat formed at Science Leadership team with Principal Kathy Marin and the four teachers men- tioned above. They were selected to participate in the FOSS Leadership Academy, a program co-spon- sored by the Lawrence Hall of Science, Delta Publish- ing and the K-12 Alliance. The Academy works with teams from 10 districts in the state to explore how to build sustainable science education.

As part of their Academy experiences, this team gathers monthly to reflect on the effectiveness of their science program. Each team member meets with a grade level buddy to discuss students’ under- standing of concepts, recording in notebooks, assess- ments, etc. In fact, the team recently invited pairs of students to present their notebooks and a lesson to school board members.

Science Leadership Team members and their buddies regularly host a Science Night where parents and siblings get the opportunity to perform science ex- periments – investigations that students have done earlier with teachers in their classrooms. Science Nights are popular and well-attended events that re- ally connect the community to science.

While there are many duties on Pat’s plate, one of her favorite involves working with replenishment clerk Sylvia Miro to nurture and deliver list organ-

Are We Really Engaged?

BY JODY SHERRIFF

In the 5E lesson design, the purpose of the first E, or Engage phase, is to hook the interest of the students and uncover present student thinking/ understanding of the lesson concept. But “hooking the interest” does not equate, the teacher says, “Today we are going to have fun doing this exciting science experiment.”

Instead, the Engage phase is an opportunity for teachers to probe student understanding and for stu- dents to share their prior knowledge about an object, problem or event. By drawing out students’ initial think- ing, the teacher has a tangible starting point for design- ing instruction that will build from students’ ideas.

Probing student thinking does two things: it allows the teacher to know what the student is thinking and how the student’s ideas may have developed, and helps the teacher construct instructional strategies and experiences that can bridge where students are in their present under- standing to the desired conceptual understanding. During the Engage, the teacher provides strategies that help students mentally focus on the lesson con- cepts, promote student thinking and surface ideas in a non-judgmental way. By sharing their thinking with oth- ers, students have opportunities to consider their ideas in light of their peers’ explanations and arguments.

Strategies used during the Engage are varied and depend on the information the teacher needs for adjust- ing instruction. Activities used can be as short as 10-15 minutes or can last as long as a whole class period. It depends on the nature of the information the teacher desires.

For example, a quick and simple way to uncover student thinking is for the teacher to make statements about a topic and ask the students to show “thumbs-up” if they agree or “thumbs-down” if they disagree with the statement.

More detailed way to see what students are think- ing is to show them a phenomenon (e.g., Diet Coke and regular Coke in a tub of water) and have them work in groups to make a diagram explaining the phenomenon (what is happening) at the molecular level that explains why diet soda floats and regular soda sinks). Students discuss in their groups what they think is happening, make a diagram and then share with the class. By lis- tening to the discussion and analyzing the drawings, the teacher has immediate information as to the students’ understanding (or confusion) of the phenomenon (iden- tity).


Here are two examples from the book. In Focused Listing (pg. 95), students list all the words, terms, facts, ideas, experiences that they can remember on a specific topic. Students work in groups to develop their lists and later, they share their lists and look for similarities. This activity is a helpful gauge for the stu- dents’ readiness and familiarity of the topic.

Four Corners (pg. 97) is a strategy in which stu- dents make their ideas public by meeting “in the cor- ner” with other students who have similar ideas. In the corner, students discuss their ideas and clarify their thinking. Teachers can visually see which idea individual students have as well as which idea is most prevalent in the class.

All in all, a successful Engage phase results in stu- dents being puzzled by – and actively motivated in – the learning activity, both mentally and physically. By being engaged, students are inspired and truly ready to ex- plore and construct new ideas.

I ♥ Collaboration

BY DAVID HARRIS

Sometimes a collaboration is more than the sum of its partners. A good example is the partner- ship between the Escondido Union School Dis- trict and CSU San Marcos.

“I have an idea for a content map for middle school math. Let’s meet to discuss the idea.”

These two email comments were exchanged last year between district personnel and CSUSM faculty. Even though these topics were not officially stated goals of their formal collaboration plan, both part- ners followed up with each other – it was just natural to share ideas and important issues with each other.

There has been a long relationship between the district and CSUSM. In the past year and a half, how- ever, the relationship has blossomed into a much more coordinated one, especially in terms of math professional development.

Today, the relationship has formal structures and informal channels of communication which gives both institutions a wider understanding of each oth- er’s values as well as an increased collaborative effort for all math professional development.

The new collaboration began with the funding of a Distinguished Teacher in Residence (DTiR) grant for EUSD and the math education professors of the College of Education at CSUSM, Dr. Brian Lawler and Dr. Rong-Jhi Chen. The first-year goals of this grant was to “collectively work with EUSD middle school principals and lead mathematics teach- ers – to identify a best practices model specific to the math instruction in EUSD. This plan included creat- ing observational tools and coaching practices with the principals who would support teachers as they developed these best practices.

During the first year, the collaboration also de- signed and implemented a process for textbook eval- uation, pilot and selection.

Professors Lawler and Chen met regularly with dis- trict coaches and facilitators not only to develop the model, but also to be knowledgeable about all aspects of mathematics professional development in the district.

The K-12 Alliance has a long history with both entities and, overall, this coordination enhanced the current fourth and fifth grade math projects. Com- munication between these groups of leaders became regular and indispensable and it continues to grow.

Throughout this collaboration period, a two-way communication of information flourished between the College of Education and the district teachers. The DTiR professors were included in district discus- sions about math education beyond DTiR activities, leading to consistent contact. The district benefited from the general expertise of these professors, and the professors more deeply understood the needs of the EUSD math teachers. It became commonplace for each “partner” to look to the other when consid- ering topics for professional development.

Providing comprehensive and cohesive profes- sional development has enabled sites to link district specific educational programs with their PLCs. For example, when the district designed a new content map for middle school math, the design team included the professors, teachers and coaches. Collaboratively planned, the maps provided a consistent message of what content was important for all students.

When the San Diego County Office of Education was enlisted for an overarching district professional development series, EUSD made sure the DTiR profes-
Ask a Cadre: Not All Organs Are Created Equal

A recent fifth grade Teaching Learning Collaborative (TLC), teachers were designing a lesson that would illustrate how living things are organized. The teachers were very familiar with animals in terms of "cell," "tissue," "organ," "organ-system" and "organism," but what about those other living things – plants?

The textbook used the word "structure" for plant parts. The teachers wondered: What gives? What are the appropriate words in plants as living things? Organ? Structure? Something else? What about systems? What systems to plants have that are comparable to animals? Should the word "system" be something else in a plant?

For example:
- Transportation (rather than circulation)
- Reproduction (same as reproduction) (rather than digestion)
- Transpiration (rather than excretory)

To shed some light on this dilemma, we turn to our trusted CSU San Bernardino Biology Cadre member, Dr. David Polcyn for advice. Here are his thoughts:

"Ah, square pegs, round holes. There aren't really exact equivalents for the different levels of organization. Some textbook authors in general have tried to force things, but it gets messy, especially when it comes to physiological systems. With plants, we usually talk about:
- Cell types (parenchyma, collenchyma, sclerenchyma)
- Tissue systems (dermal, vascular, ground/fundamental)
- Organs (roots, stems, leaves; with flowers and fruits as modified leaves, which some view them as "reproductive" organs).
- Sometimes "meristem" or "merismatic" is included as another tissue system – meristic tissues are the only cells which divide in a growing plant.

With regards to animals and plants, there really isn't a one-for-one comparative physiological system. You can talk about "transport systems" (organ systems) and maybe "gas exchange systems" (stomata, etc.), but there really isn't a good equivalent for systems like digestive, excretory, nervous, muscular-skeletal, etc. This just reflects different organizations and ways of life.

But, then again, many animals don't have much beyond the tissue level of organization either; so a large number of animal phyla are missing many organs and/or organ systems we tend to think of as "tissues" for animals.

Our minds (and textbooks, even at the college level) are polluted by the self-serving notion that vertebrates (and mammals, in particular) are models for "living things." Vertebrates are merely a drop in the sea of life.

In the end, I know that's what we are faced with, so I find it helpful to first explain that there are a variety of patterns of organization ("emergent properties"), and that we are only going to examine a few... then launch into the traditional cell-tissue-organ and organ-system-organism blur..."

So back at our TLC, as we nod our heads in understanding, we finally realize that although a rose by any other name may smell as sweet, it is definitely not an animal.