What's The Big Idea?

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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, reflect on their learning, and draw conclusions supported by evidence.

Jana also uses science notebooks to assess what students know which in turn helps her design instructional interventions. In particular, she analyzes student notebooks to identify areas where students are experiencing difficulty. In her experience, students typically need additional support in three areas:

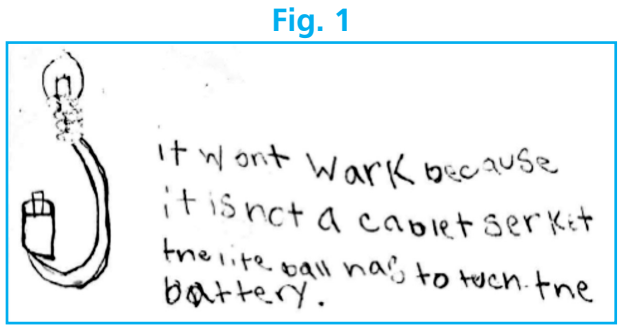
1. content misconceptions;
2. language scaffolds for effective communication; and
3. metacognition, such as processing their ideas into writing.

In this example, Jana wanted students to understand that in order for electricity to flow, a complete circuit or path is needed from a battery to the receiver and back to the battery.

Jana designed the first learning experience as an exploration; students were given a battery, wire and light bulb and instructed to make the bulb light. They worked in groups for several minutes, trying different configurations. Once they got the bulb to light, they discussed how this happened (complete path for flow of electricity) and what happened when they "broke" the connections (incomplete path resulting in no flow of electricity).

One student, Gloria, drew a complete circuit and her explanation of why the bulb lit is shown below in Fig. 1.

Fig. 1



The text reads: "It wont wark [work] because it is not a cablet [complete] serket [circuit] the lite [light] ball has to tuch [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!"

Given the above, Jana made two interventions based on the identified content, language, and metacognition needs of the students. The content intervention was done whole class. The language and metacognitive interventions were targeted for students who had experienced difficulty in those areas.

"First, I asked students to rebuild their circuits with the instructions that the light bulb could not touch the battery directly…could they make it work?" says Jana. "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.

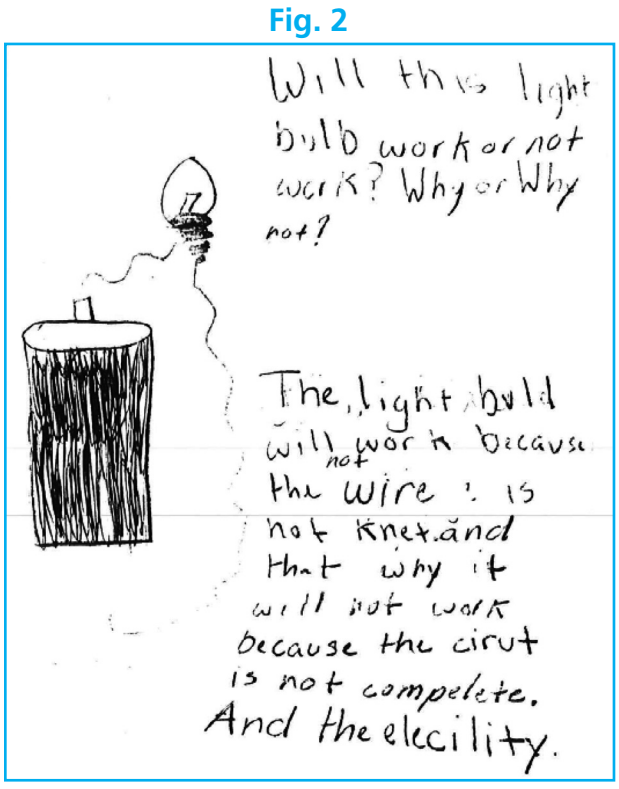
"Third, I modeled how I would answer the question: 'Why is a complete path necessary?' by doing a think aloud.

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

The various activities provided temporary scaffolds for students to communicate their understanding – orally, with diagrams, and in phrases. In essence, they were pre-writing activities that gave them a chance to practice communicating their knowledge.

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

Fig. 2



The text reads: The light bull [bulb] will not work because the wire is not knet [connected] and that why it will not work because the cirut [circuit] is not compelete [complete]. And the elecility [electricity].

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

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DIRECTOR'S COLUMN

Farewell to a Great Soul

BY KATHY DIRANNA

A great soul serves everyone all the time
A great soul never dies
It brings us together again and again
– Maya Angelou

One great soul, Evaline Athena Assad Khayat 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 even more lives….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.
- Family is the most important thing in your life.
- Traditions are important.
- Fried chicken and apple pie make everyone feel welcome, especially new sons-in-laws.
- Hug people you love often.
- A good Methodist hymn, sung loudly and with others, can help everyone feel better.
- Always tell the truth.
- Karma exists – if you do good, it will come back to you.
- You can overcome tragedy in your life.
- A little flirting with waiters and grocery clerks keeps the heart in good shape.
- A periodic cuss word, spoken aloud, can be a very good thing.
- You can be a mother to many people other than your own children and you should be.
- At 89, you get to eat as many See's scotch mallows and chocolate ice cream as you want and that's a pretty good deal for lasting that long.
- Teaching is an expression of love for others.

And so to all of you who work so hard to make this world a better place, who work day in and out to help your students grow and be all that they can be, in the words of my mother: keep your eye on the prize, and tell the people who you love that you love them, often. ■

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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.

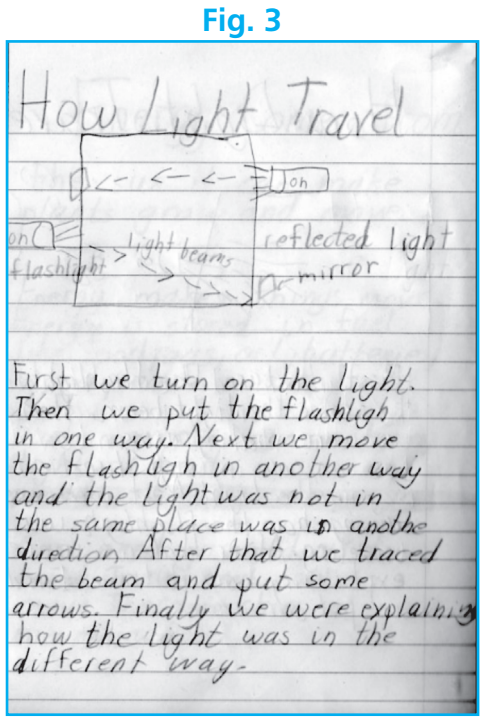
In the second step, Leslie evaluates students' work to make decisions about instruction, intervention and assessments. "When I analyze student work, I analyze my teaching," she says. "What went wrong? How can I make it better? What are my next steps to help them with their understanding of the concept?"

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.

Fig. 3



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, "They [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 __. The __ reflect off the __ and travel in ___ to the ___.

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

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LEADERSHIP

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 Ciaglia's class are squealing with delight as they discover how light bulbs work; Wendy Fountas' students are carefully adding plants to terrariums full of fish as they observe "environmental factors."

Further down the hall, fifth grade teacher Anthony 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 plywood in made.

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

Pat Smith

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 Whittier 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 Presidential Science Teachers Award and was recently honored as Teacher of the Year by the Youth Science Center of the San Gabriel Valley.

Pat's road to supporting the WCSD began in 1998 when she received a three-year grant to promote inquiry-based, hands-on science from the National Science Foundation, CAPSI (Caltech) and Pasadena Unified City School District.

As the school district Program Coordinator for SEARCH (Science Education Actively Realized in Children's Hands), Pat worked with district teachers to develop a kit-based program in WCSD that networks 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 mentioned above. They were selected to participate in the FOSS Leadership Academy, a program co-sponsored by the Lawrence Hall of Science, Delta Publishing 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' understanding of concepts, recording in notebooks, assessments, 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 experiments – investigations that students have done earlier with teachers in their classrooms. Science Nights are popular and well-attended events that really 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 living organ-

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TEACHING & LEARNING

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 mean 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 students to share their prior knowledge about an object, problem or event. By drawing out students' initial thinking, the teacher has a tangible starting point for designing 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 it helps the teacher construct instructional strategies and experiences that can bridge where students are in their present understanding to the desired conceptual understanding.

During the Engage, the teacher provides strategies that help students mentally focus on the lesson concepts, promote student thinking and surface ideas in a non-judgmental way. By sharing their thinking with others, 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 adjusting instruction. Activities used can be as short as 10-15 minutes or can last as long as a whole class period. It truly 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.

A more detailed way to see what students are thinking 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 phenomena (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 listening to the discussion and analyzing the drawings, the teacher has immediate information as to the students' understanding (or confusion) of the phenomenon (density).

Not sure how to engage your students? Page Keeley's new book, Science Formative Assessment, (Corwin Press, 2008) offers 75 practical strategies for linking assessment, instruction and learning. This book offers innovative ways to engage students and provides teachers with useful information for designing meaningful learning sequences.

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 students' readiness and familiarity of the topic.

Four Corners (pg. 97) is a strategy in which students make their ideas public by meeting "in the corner" 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 students being puzzled by – and actively motivated in – the learning activity, both mentally and physically. By being engaged, students are inspired and truly ready to explore and construct new ideas. ■

COLLABORATION

I ♥ Collaboration

BY DAVID HARRIS

Sometimes a collaboration is more than the sum of its partners. A good example is the partnership between the Escondido Union School District and CSU San Marcos.

> *"I have an idea for a content map for middle school math. Let's meet to discuss the idea."*
> *"Have you seen the latest legislation proposed for education? We should be prepared to deal with what this means for our work."*

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 partners 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, however, 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 other's values as well as an increased coherence 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-Ji Chen. The first-year goals of this grant were to collectively work – along with EUSD middle school principals and lead mathematics teachers – to identify a best practices model specific to the math instruction in EUSD. This plan included creating 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 designed and implemented a process for textbook evaluation, pilot and selection.

Professors Lawler and Chen met regularly with district coaches and administrators to not only 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. Communication 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 discussions 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 considering topics for professional development.

Providing comprehensive and coherent professional 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-

COLLABORATION, CONTINUED ON PAGE 4

Ask a Cadre: Not All Organs Are Created Equal

At 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? And 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)
Tropisms (rather than nervous)
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:

"Ahhhhhh…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.

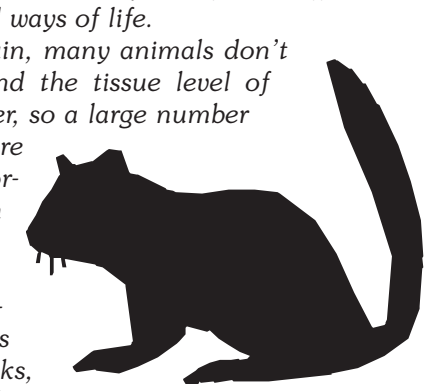
With plants, we usually talk about:

- *Cell types (parenchyma, collenchymas, 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 meristematic" is included as another tissue system – meristematic 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" (or vascular systems) and maybe "gas exchange systems" (stomata, etc.), but there really isn't a good equivalent for systems like digestive, excretory, nervous, musculo-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 a "typical" 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 blurb."

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!

Experience and Expertise: New MSP Grant Announced for San Diego area

California Math Science Partnership (MSP) grants have just been announced and once again, the K-12 Alliance is a partner in a funded proposal! We are thrilled to now have been a part of all seven cohorts – and equally excited to be improving science education for teachers and students in East San Diego County.

The new MSP, Inventing, Designing, Engineering, Activities in Science (IDEAS), is a collaborative effort of Lakeside Union Elementary SD, Cajon Valley Union SD, and Santee SD, San Diego State University, the San Diego County of Education (SDCOE), and the WestEd/K-12 Alliance.

It's not the first time these organizations have worked together – *IDEAS* partners have a long history of working as a team and no doubt they will be able to make a difference to teachers and students alike as they build a professional learning community in science education.

With the gamut of experience and expertise, *IDEAS* partners include district teachers, university scientists, educators, scientific corporations, and professional development providers. Gloria Rodriquez Banuelos will serve as the K-12 Alliance Regional Director for this grant.

Overall, grant partners will use their existing resources to:

- infuse technology into the lives of teachers and students by creating an online learning community;
- make technology tools, such as scientific probes, for student projects;
- tap into the local scientific knowledge and involve volunteer science professionals to work alongside teachers/students to design projects that can assess students conceptual understanding in science; and,
- create pathways for university professors, undergraduate and graduate students to continue to engage in K-12 science education endeavors.

Seventy teachers from grades 3-8 will participate in the professional development program that consists of a Summer Institute (which will spotlight physical science, Earth science and life science); a Teaching Learning Collaborative (which will focus on effective lesson design); and after-school sessions to analyze student work and design classroom interventions. Six district teachers will be mentored to become leaders in their district.

The IDEAS grant began this January and will continue through September 2013.

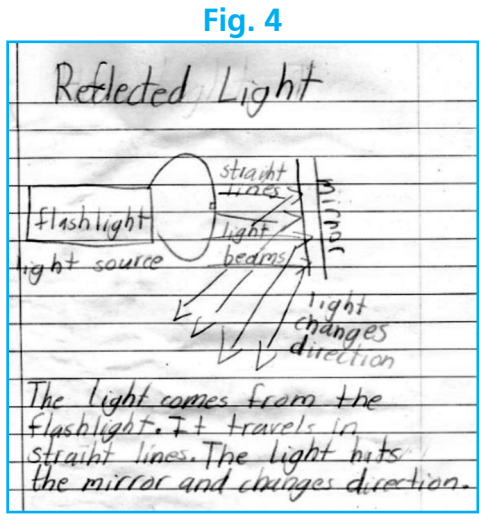
NOTEBOOKS..., CONTINUED FROM PAGE 2

shown (Fig.4).

Leslie's redesign of the learning activities included two types of light sources, two language scaffolds (verbal and written purposes) and multiple student-student interactions. These changes permitted students to internalize not only the content, but also the language needed to express the content. The scaffold (sentence frames) were removed once students gained experience in expressing their thinking.

Because of her decision-making, Leslie realized that in order to develop metacognitive skills and benefit from reflecting in their notebook, students' words must be authentic and free from teacher designed sentence frames.

Fig. 4



Targeting Interventions Based on Needs Expressed in Notebooks

Overall, Jana and Leslie based their instructional decisions by the discoveries they made after analyzing students' work in their notebooks. Although each took a different road, their goals were same: 1) deepen students' initial science experience: 2) help students process their thoughts into words; and, 3) provide them with multiple opportunities to communicate their conceptual understanding, orally and in writing.

Leslie and Jana know the complexity associated with assisting students in demonstrating what they know. Leslie provided additional experiences with light and provided various sentence frames to help students organize and communicate their thoughts. Leslie understood that scaffolds were temporary and must be deliberately eliminated as students develop literacy skills to express their ideas.

Jana had her students repeat the same science experience with a different set of instructions. In addition, she modeled the task for her students with a think aloud. Finally, students practiced communicating their thoughts clearly through student-to-student interactions. Leslie's students practiced communicating their ideas with each other orally before individually writing in their notebooks. And Jana's groups of students used large whiteboards to illustrate and then share their understanding before individually writing a notebook entry.

By using notebooks as windows into student thinking, Jana and Leslie were able to design "just-in-time" instruction to keep students motivated and eager to learn more. And this is just what good educators want to see every day they come into their classrooms!

BRINGING WONDER, CONTINUED FROM PAGE 3

isms to the schools. With these creatures, science certainly comes alive for students and teachers alike.

"With education funds being cut in California at an alarming rate, we have learned how to breed our own critters in most cases," she explains. "Crayfish nurseries, guppy and goldfish tanks, isopod condos, worms and snails are easy to maintain if you have the stomach for it," she says. "Our specialty is the gulf fritillary butterfly as we raise them on passion fruit vines on each campus."

So, don't be surprised if after a walk through Daniel Phelan School, as you head outside, you are greeted with lovely butterflies, a symbol of the enduring power of science to bring awe and inspiration to children of all ages. Thank you, Pat for making it happen every school day of the year!

COLLABORATION, CONTINUED FROM PAGE 3

sors were involved as collaborators for the middle school math portion. Once again, this collaboration provided a clear and consistent message for teachers as to what was important for increasing student understanding.

It is currently the second year of the partnership and this mutual respect continues. The feedback loop is short, real and requires no translation between the partners. We feel free to be opinionated and disagree, but overall, we see ourselves as a team.

"Hey, I am writing an article about our collaboration. Could you look it over?"