Using Poetry to Teach about Minerals in Earth Science Class

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ABSTRACT

Incorporating poetry in science teaching expands the curriculum beyond content knowledge or process skills and enhances learning in creativity and affective skills. A high school earth science teacher and a college education professor team-taught a lesson to ninth graders on using poetry to learn about minerals. The professor, a geologist, shared an electronic slide show of poems (*Diamond* and *Tiger Eye* are included in the article) she had composed about gem minerals that incorporated physical properties, formation, uses, and other information. After instruction, students researched a mineral of choice and wrote poems that contained facts and a personal reaction to the mineral. Students' most difficult aspect was finding words to express their ideas in rhyme. The most satisfying part was the sense of accomplishment in producing a scientific poem. About half of the students changed their perceptions of earth science as a result of mineral poetry exploration. Another benefit of the collaboration involved career education. Students commented that they now understood more of the job of a mineralogist and the passion one can bring to a subject through poetry.

INTRODUCTION

Incorporating poetry in science teaching has many benefits. The images and metaphors in a poem can clarify and intensify the meaning of science content. "Poems touch us at deep levels, levels we don't or can't always articulate. Meaning carried by metaphor and the condensed, tight language of a poem may penetrate faster for learning disabled students as well as having great appeal to gifted students because of a poem's many layers and the worlds contained, but not necessarily voiced. In their richness, poems can often be the source of 'aha,' or 'Now I get it'" (Walders, 2000, p. 2). Abisdris and Casuga (2001), who describe how to use poetry in teaching Rutherford's discovery of the nucleus, note that science's language, like that of poetry, is metaphorical in nature. Because many science concepts are abstract, scientists use metaphors and create models to help them in understanding and conceptualizing knowledge. A natural parallel to scientific thinking, then, is poetic imagery.

Daniel Donaldson, author of a recent paper on teaching geography through poetry, (2001) notes "Poems ... are not written simply to communicate information. They exist to allow humans to expand their sense and perception of life, and to widen and sharpen their connections with the world around them." Making connections to concepts and experiences outside of science class is important. The amount of time spent in science class relative to other settings is small; significant learning extends outside the classroom. Science teachers must provide connections to other life experiences to place science learning in meaningful context. Studies of experts in many fields reveal that experts' knowledge, in contrast to that of novices, is organized around important ideas and concepts (Commission on Behavioral and Social Sciences, 1999) and is *conditionalized* – includes specifications of the contexts in which it is useful (Glaser, 1992). Alerting students to applications of science knowledge helps them organize and form a network of interrelated concepts.

Integrating poetry into science class expands the curriculum in valuable ways. Robert Yager, in "*A Vision for What Science Education Should Be Like for the First 25 Years of a New Millennium*" (2000), casts science education in a broader perspective than merely knowing and understanding science content or exploring and discovering science through process skills. He defines six domains of science education (concepts, process skills, creativity, affective skills, applications, and the world view). Science poetry can provide the opportunity to address two often neglected domains, Domain III: Imaging and Creating, and Domain IV: Feeling and Valuing. Poetry appreciation and composition involve visualizing and producing mental images, combining ideas in new ways, and communication of information, all part of Domain III. Experience with poetry also provides the opportunity to develop positive attitudes toward science, to explore human emotions, and develop sensitivity and respect for the feelings of others, components of Domain IV. Using poetry to teach physical properties of minerals, the beauty of gem minerals, and the human uses and folklore of minerals will address several of Yager's science education domains, thereby enriching a student's experience.

Mark Alber (2001), in his discussion of using poetry in chemistry class, notes that early on, students choose separate camps with regard to learning science. One group finds science "difficult and unappealing, not simply because they are not mathematically inclined, but also because they find the language, concepts, and people of science abstract and alien" (p. 478). These students find science demanding and lacking in creativity. In the other camp are students who are comfortable with mathematics and abstract reasoning. Even members of this group, however, may not realize the importance of creativity in science inquiry. His observations echo the need for an expansion of the science curriculum to include the ideas and skills in Yager's last four domains.

Mike Watts (2001), in describing the important role of poetry in humanizing science agrees that "science and poetry are so often caricatured as being at opposite ends of a cultural spectrum, the one so dour, impersonal, detached and stone-cold logic, the other emotional, irrational, imaginative and artfully eloquent... What are needed... are 'creative trespassers' as a means of ending the 'cold war' between the two cultures" (p. 198). In 1998, Watts put out a "call for poems" through an international Internet mailbase and a science journal in which he asked

1. Find a mineral that you like a lot. Maybe it's your birthstone, or your favorite color. Perhaps you have some jewelry containing this mineral or own some other item made of this mineral. Maybe you have seen a beautiful specimen of this mineral. Perhaps you like the mineral because it's worth a lot or has unusual properties. If you don't know which mineral to choose, browse some of the Internet sites with photographs of minerals and choose one that looks interesting.
2. Brainstorm a list of everything you know about the mineral. Include color, habit, crystal form, hardness, luster, streak, gem names, industrial uses, places where it is found, the origin of its name, and any other information you can find. You should research your mineral so that you become an expert on it. Find out as much as you can.
3. Write the mood of your poem and your emotional reaction to the mineral. Poetry is communication. What feelings, qualities, and main ideas do you want your poem to convey? Some examples include: beauty, peace, simplicity, danger, intrigue, pain, joy, luxury, conflict, energy, speed, patience, honesty, humor, and mystery.
4. Make a list of other things or events that give you similar feelings. List other things that have the same colors, shapes, lusters, etc. Then look at your list and choose the items that best match the mood and ideas you want to present.
5. Start with a short poem. Remember that your poem does not have to rhyme, but it should have rhythm or smooth flow of words. It should tell several facts about your mineral and also express a mood.
6. Read your poem out loud to yourself. Does it have a rhythm that continues throughout the poem? Change words – substitute other words or change the order of words – to improve the rhythm. Read and revise the poem until it sounds very smooth.
7. Ask a friend to read your poem and make suggestions. Use these suggestions to improve your poem.

Table 1. Guide for Researching and Composing a Poem

creatively trespassing science educators to describe their use of poetry. He received over a hundred contributions that he classed into three main categories: meaningful, profound verse; frolicsome, amusing, and diversionary poetry; and poems that emphasize observation, imagination, and emotion. The driving motivation of these teachers was the hope that students, through poetry, might have a conceptual change, a restructuring of knowledge and ideas, and a powerful means of expressing themselves.

Finally, the creative writing of poetry involves problem solving, as suggested by Marlow Ediger (2000). Students with problem-solving dispositions have the willingness and confidence to take on new and difficult tasks. They have a repertoire of problem-solving strategies; they are able to view problems from different perspectives and break down complex tasks (Schoenfeld, 1985). Researching a mineral of choice, determining its diagnostic properties, formation, and uses, then combining this information with a personal reaction in rhythm or rhyme can be quite a challenge. For all of the above reasons, we decided to use poetry in our ninth grade earth science class.

USING POETRY IN NINTH GRADE EARTH SCIENCE CLASS

Ediger (2000) provides several guidelines for writing poetry in science class which we followed: students select their own topics and become knowledgeable about them; assessment focuses on what can be achieved developmentally; students choose the type of poem to be written; and the teacher encourages students and provides quality poetry models. Five poems featuring gemstones were made into electronic slide shows that were illustrated with striking photographs of mineral specimens and metaphorical images. Before showing each presentation, we told our students several images from the poem and asked them to guess the mineral or gem being described and explain their reasoning. After students viewed a poem, they reviewed the mineral facts the poem contained and discussed its overall mood and message. We also passed around mineral and gemstone specimens related to the poems. Our students were given a list of Internet sites featuring information about minerals so that they could choose a mineral of interest and conduct research. Then, students used a writing guide (Table 1) to help them in composing their poems.

Two of the poems we used are featured here.

Diamond
A diamond is dazzling, dizzyingly bright,
An adamantine crystal glittering with light,
A million mirrors reflecting a star;
A Fourth-of-July sparkler in a faceted jar.
From the depths of the mantle, a diamond is born:
Intense heat and pressure make kimberlite form.
Within it are crystals, octahedral in kind:
Rough uncut diamonds for the lucky to find.
Inside, carbon atoms bond closely together,
Holding so tightly, they stay locked forever.
Impenetrable surface, the hardest on Earth,
Keeping a polish to show off its worth,
Refracting a rainbow of fine flashing fire,
Promising passion and answering desire,
A diamond means permanence, lasting through time;
An eternal torch for two lives that entwine.
A lightning bolt giving a spark to ignite
A blaze that rages consuming the night.
And after the smoldering embers are gone,
The flames still will flicker as memories live on.
But diamonds can fracture if not handled with care.
Its strong face can shatter, you'd better beware.
If struck at an angle, a diamond will cleave,
A fragmented stone is what trauma will leave;
Like hundreds of fireflies fluttering away,
Their lights growing dimmer and fading to gray.
A diamond's a paradox: ice that glints flames;
Delicate beauty scratching glass window panes,
Rare, exquisite, a piece of the sun,
Small but expensive, now don't you want one?
(Audrey C. Rule)

This poem depicts many physical properties of diamonds; their adamantine luster, extreme hardness, octahedral crystal shape, and cleavage; along with formation under intense heat and pressure in the mantle. It also portrays the human side of diamonds, in particular, their use as expensive tokens of everlasting love. Words such as "depth," "closely together," "tightly," "locked forever," "entwine," "and "permanence" express the diamond-giver's hope that the relationship will be intimate and endless. The images of light presented (star, sparkler, torch, spark, blaze, lightning, fire, fireflies, sun) allude to diamond's high index of refraction.

Tiger-eye
Tiger-eye's as mysterious as All Hallowed's Eve:
Through the long shadows this wary cat weaves.
It hides like a bandit peeking through bars,
Eyes twinkling brightly like scintillating stars.
It's lying in wait for your trick or treat,
Changing its colors as it retreats:
Yellow for summer, amber in fall,
Black during winter - the darkest of all.
Then suddenly SPRING, the tiger leaps out,
Golden stripes shining, pacing about,
Muscles rippling a sheen down its back,
Like moonlit rocks gleaming through repeating tracks.
Tiger-eye's chatoyancy comes from the rows
Of aligned mineral fibers reflecting the glow
Like subsequent windings of silk on a spool,
Making clear quartz a magnificent jewel.
Tiger-eye hypnotizes; watch its eye wink.
Undulations entrance you before you can blink.
See its tones shift, always moving ahead.
How could you choose another instead?
(Audrey C. Rule)

This poem describes tiger-eye's unusual chatoyant luster. The quartz gem's striped appearance in which color varies between yellow, gold and black was thought to be caused by atom-by-atom quartz replacement of aligned mineral fibers that were originally crocidolite (a fibrous form of the amphibole riebeckite) for 130 years. However, recently (Perkins, 2003), Heaney and Fisher (2003) have shown through microscopic examination of thin sections of tiger-eye that the quartz occurs as columns that are too large and fault-free to have been formed by replacement. They suggest that quartz and crocidolite crystals simultaneously condensed from hot mineral-rich fluids that moved through cracks in the rock. The precipitating minerals filled openings in a "crack-seal" mechanism. Later, crocidolite changed to limonite, yielding a yellow to brown or black coloring. The mysterious mood of the poem is reinforced by words such as "shadows," "wary," "peeking," "lying in wait," "trick," and "hypnotizes." Words and phrases conveying the image of light movement across a Tiger Eye stone include: "twinkling," "changing," "SPRING," "leaps," "shining," "pacing," "rippling," "gleaming," "undulations," and "shift."

STUDENT POETRY AND REACTIONS TO THE EXPERIENCE

After students had completed their poems, we asked them to reflect on the experience in five ways: what they learned from the mineral poems presented by the first author, a mineralogist/education professor turned guest speaker in their high school classroom; the most difficult aspect of writing their poems; the most satisfying part of the project; what they learned about themselves during the process; and if their perceptions of earth science had changed in any way as a result of this activity. These perspectives will be interwoven with selections from their poetry below.

Student reactions to the poems shared by the first author were very positive. Students reported, "Learning doesn't have to be boring and conventional." They were surprised at "just how much information you can put in a poem about minerals." One student remarked, "Poetry can help you understand things better." The ninth graders mentioned the factual information they gleaned from the poetry: "bits of information about each mineral;" "what to look for in a gem;" "about hardness, luster, and cleavage;" and "gems are various colors." Our earth science students produced many effective poems that incorporated facts about mineral properties in interesting ways. Excerpts from student poems that highlight mineral color follow:

"The brilliant shades and variations of blue,
Shine as the night sky, a miraculous hue." (from *Sapphires* by Meg Whitfield)

"It shines so bright, from everywhere be seen,
And looks just like, a green jellybean." (from *Emerald* by Stacey Rice)

"Its purple color varies from dark to light.
The color might match a bruise you get from a fight." (from *Amethysts* by Vanessa Schrader)

A student's insight, after viewing the slide presentation featuring poetry about mineral gems, expressed surprise that "a rock's color and luster are the make or break in how we enjoy it." Students described mineral luster in these lines:

"The black shade is glossy, like a black cat at night.
The moon can be seen, in the other tone, white." (from *Onyx* by Molly Cichy)

"It shimmers in the light like a million stars on a clear night." (from *Diamond* by Kristin Smith)

Although we reminded students that their poems need not rhyme, most students felt compelled to produce rhyming verse. The overwhelming reply (two-thirds of the students) to our query of the most difficult part of the project was trying to make their compositions rhyme, have rhythm, or "flow". However, one student observed, "Poetry doesn't have to rhyme as long as it expresses its point thoroughly." Another student applied this principle as she featured streak in her poem about graphite:

"Leaves a dark-gray streak to write things down,
Or on the tip of your thumb.
It's smooth but greasy to the touch,
Like a bottle of oil with a little dripping down the side." (from *Graphite* by Jillian Pritchard)

Another challenge described by several students was finding a unique mineral with enough interesting information for the poem.

I groaned and I moaned as I struggled to find,
A stone so beautiful that was worth all my time
One caught my eye, I gasped with great glee
The mineral I speak of is Aquamarine. (from *A Mineral Poem: Aquamarine* by Mura Gichane)

Most students chose a gemstone, often the student's birthstone, with diamond being the focus of eight poems, followed in popularity by emerald, ruby, sapphire, amethyst, topaz, and aquamarine. A student observed that the exercise "made earth science feel a bit more personal, like it had to do more with me than I originally thought." Several of these gem poems mentioned hardness because this property allows a jewel to keep its brilliant polish:

"With a hardness of nine on the Mohs scale,
The most valuable are vivid, not light and pale." (from *Sapphire* by Caitlin Pike)

"It is not the hardest and can be fashioned,
But only few can scratch it, such as diamond." (from *Topaz* by Chris Bourgeois)

Other student insights included, "As I worked on my poem, I learned that I didn't know as much as I thought about the mineral I wrote my poem on," and "I can research things for a project and actually not hate it." Another student located a mineral not presented in class and remarked on the cleavage of the beautiful deep-green mineral, dioptase (copper silicate hydroxide):

"It has stubby crystals with rhombohedral cleavage,
It's found in copper veins with oxygen leakage." (from *Dioptase* by Allen Irwin)

The recurrent reply to being asked to describe the most satisfying aspect of writing the poetry was a sense of accomplishment: "Finally being finished after the struggle to make it," "I was able to complete it and I thought I did an excellent job on it," "Knowing I wrote a poem that had scientific merit," and "It sounded good and gave information about the rubies." Other students enjoyed learning "a little more about a mineral," or "learning about topaz because it is my birthstone." Being able to finally produce rhyme gratified many students: "I made most of the words rhyme!" and "How well it turned out because it rhymed and explained the gem well at the same time." Here are some examples of successful rhymes that address crystal form and habit:

"Garnet crystals can have twelve sides, or maybe even more,
Because that number can increase to twenty-four." (from *Uvarovite Garnet* by Tim O'Connor)

"…the concentric bands might reveal a precious eye,
Or within a landscape of dendrite trees, Agate might lie." (from *Agate* by Jacob Pagano)

Several student poets wrote about chemical composition:

"Chemical composition FeS_2.
How do you like it coming at you?" (from *Pyrite: The Fool's Gold* by Sean Bonnell)

"Made of aluminum oxide, Al_2O_3,
Can be found from sea to sea." (from *Rubies* by Brooke Sterio)

In discussing how the activity changed the student's perception of earth science class, a student remarked, "It gave me further understanding about minerals and how they formed, and after completing this assignment, I realized that everything happens for a reason and earth science explains a lot of these reasons." Some students discussed the mineral's formation:

"Diamonds are crystallized at very high pressures,
So many kilometers down, too many to measure!
…To get to earth's surface, magma is their transportation,
But only after they have undergone crystallization." (from *Diamonds Are a Girl's Best Friend* by Nora Armenta Alonso)

"This mineraloid comes from volcanic pools:
It forms once the lava cools. " (from *Obsidian* by Patrick Nyman)

A student mentioned the challenge of "trying to relate minerals to life." Another commented that creating mineral poetry changed his view of earth science because "I realized earth science relates to our lives," as another student observed, "I realized that earth science isn't all just about facts and history." Several verses featured human use of minerals:

"Halite is a mineral full of flavor,
Table salt is used in our favor.
Halite, broken into many small cubes,
Is very important to our use.
Not only does Halite produce table salt,
It also helps to make ice melt." (from *Halite* by Josh Gordon)

"Used in precision instruments such as watches and lasers,
The importance of this gem for industries never wavers." (from *Ruby* by Justin DiPipierro)

Information concerning custom and folklore was also present in the poetry:

"Discovered in China over 5,000 years ago,
It was considered royal and its popularity began to grow.
Instead of bringing great wealth,
Jade is said to preserve good health." (from *Jade* by Erik Slobe)

"The ancient Greeks said, 'It will soothe your eyes,
And rid evil spirits from all our lives.'
With a hardness of eight, and the birthstone for May,
I'd take an emerald any day!" (from Emeralds by Mary Hoefer)

Students enjoyed the integration of creative writing with earth science: "It made me feel that subjects in school relate, like poetry from English and making it

pertain to earth science;" "The project made me look at science as not just a subject of textbooks and papers and notes and pictures. You can take some information and make an interesting piece on it while learning new information," and "I found earth science more interesting because I created my own poem."

INSTRUCTORS' REFLECTIONS

The earth science teacher was very pleased with the poems students produced. "Originally I thought we would get poems that were average — poems that really didn't get across a point. I didn't know if students would have enough background knowledge to write poems that would make the minerals come to life. After completing the poem activity, I feel my students have a genuine sense of how minerals are formed and the physical properties we had discussed in class. It was nice to see that students were able to apply course information to their poetry. The best part was that the students did additional research on a mineral that allowed them to construct their own knowledge. In some verses, students arranged the information in a way that was very clever and made for easy reading and understanding. The depth with which some students were able to explain their thoughts, the power of these poems, was applaudable." An example of a powerful student poem, a stanza about the organic gem Amber (not a true mineral), included particularly effective imagery:

> "Amber, the freezing gold, that is not hot and is not cold,
> Time has kept as still as death, holding instant, every breath.
> Now from out our fading past, a scene that can forever last,
> Amber has caught in its dreaming arms, the insects and the flower charms." (*Amber* by Evan Sovring)

Another powerful student poem featured exceptional rhythm.

> "Topaz is a gemstone, it comes in several hues;
> You'll find it in pink, orange, and blue.
> A sparkling sea of beauty from the beaches of Brazil,
> Or a flame of golden embers: a treasure sure to thrill.
> A joy of many facets, a beauty to behold.
> And a keepsake to adorn you, when it's set in gold."
> (from Topaz by JoBeth Dunsmoor)

An additional benefit of this collaboration between university professors and the teacher of a high school earth science class was the opportunity for students to meet a geoscientist who was also a poet. One student remarked, "College professors will go through anything, like giving presentations to high school students, to express what they truly like." Another commented, "I learned that mineralogists study minerals and sometimes write poems about them!" Besides presenting poetry, the college professor was able to spend a few minutes talking about the crystal structure work she did as a mineralogist before switching to the field of education. Students later commented that they had found out "what a mineralogist really does in a job." One remarked, "People can study gems and minerals for a living – minerals aren't just for jewelry." Another observed, "Her job looks very fun!"

This project, however, did not change every student into a poet or geoscience lover. Some students reported that they felt they weren't very good at writing poetry. As one student put it, "I stink at writing poems." More time spent on the "how to's" of poetry might help. We only spent one class period examining poems and discussing how to write them. A joint project involving a creative writing class and an earth science class might have better results because students will be able to focus both on the structure and content of their poetry. Only half the students said this project had changed the way they viewed earth science. One student's reply was, "No, not really because it is still the same rock, but now I have learned more about it." Another commiserated, "It did not make me feel different about earth science because it's difficult no matter how people try to hide it." One activity cannot change every participant's attitude toward science. As Alber (2001) notes, students' dispositions towards science are deeply entrenched. The fact that half of the class felt more positively toward earth science after this project is encouraging. The earth science teacher plans to continue using poetry in future earth science classes. "There are some concepts, such as astronomy – the stars, solar system, universe – that you can add depth to with poetry. Actually, it lends itself to any topic in earth science that students would like to speak about."

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