A new story in grade nine science

Learning to ask meaningful questions and answer them in a systematic way that shows respect for the environment.

by **Susan M. Drake, Bruce Hemphill** and **Ron Chappell**

"We need something that will supply in our times what was supplied formerly by our traditional religious story. If we are to achieve this purpose, we must begin where everything begins in human affairs — with the basic story, our narrative of how things came to be, how they came to be as they are, and how the future can be given some satisfying direction. We need a story that will educate us, a story that will heal, guide, and discipline us."

— Thomas Berry, *The Dream of the Earth*

IN HIS COLLECTION of essays entitled *The Dream of the Earth*, historian and eco-theologian Thomas Berry speaks of the pressing need in the Western world for a "new story" with which to understand the universe, the natural world and our role within it. It is clear that the world today is in crisis. Our present-day story, one that has dominated for several centuries, is based in a vision of "progress" to be gained through human control over the natural world. It is driven by values of materialism, independence, power and oppression, and our resulting actions are destroying the planet. Whether or not they realize it, educators who believe that students must be taught to value the environment and to see themselves as part of, rather than masters of, the natural world, are already engaged in creating a "new story," a reconceptualizing of humans' role in the living world. The values consciously embedded in the new story are caring for self, others and our planet.

Berry's notion of a new story has led to the development of a Story Model in education (Drake *et al*, 1992, see Figure 1), an integrated curriculum framework that emphasizes critical thinking to explore the past, present and possible futures of the world we live in. The purposes of the Story Model are to set learning into a larger context and to begin to build the "new story" that Berry says is essential for the survival of humans on this planet.

When recent changes in Ontario curriculum guidelines called for a restructuring of grade nine science, and an outcome-based, integrated approach to education, we saw an opportunity to try different ways to engage our students. The Story Model was used as a general framework for curriculum planning. Our science classes would be studying green plants and matter; however, the topics would be set in a context for creating new ways to story our lives and thus to act in the world.

We were very clear on a major learning outcome: for students to be able to ask a meaningful question and answer it in a systematic way that shows respect for the environment as a part of the problem solving process. We agreed that this one major outcome would allow us the freedom to teach in new ways and still respect science as a discipline. If we could facilitate students' achievement of this outcome, we would be preparing them for higher levels of education and helping them develop a basic life skill as well as a positive attitude toward environmental stewardship, regardless of their path after our classes.

As we experimented with new ways of teaching, we met for up to two hours each week to reflect on our experiences and to engage in an ongoing dialogue about the philosophy of teaching and what is worth knowing. Over the year, a common philosophy emerged which guided

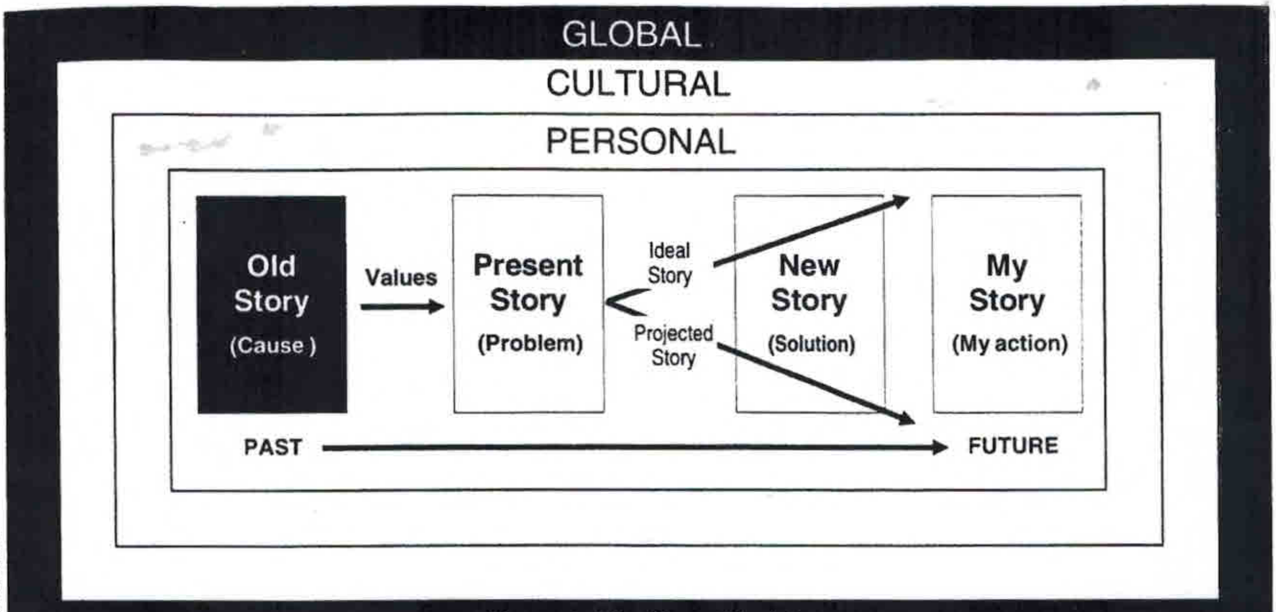


Figure 1: The Story Model

Susan Drake, 1994

Using the Story Model, environmental problems can be seen as the result of "old story" values such as materialism and power. Students research present problems, examine causes, predict the probable future if nothing is done, and then project a "new story," or ideal solution, to the problem. The final step, "My Story," is a commitment to personal action.

crucial decision-making on content and delivery. Some of our key beliefs were that:

- active learning is best
- all students can learn when and if they are motivated
- students have different learning styles
- acquiring skills that can help in understanding scientific principles and applying them to a variety of situations is more important than content (for example, to be able to develop a meaningful question and answer it in a systematic way)
- in the final analysis, we want students to respect the environment, whether or not they choose to be scientists

What we taught

WE BEGAN BY having students explore real life webs. Students put the topic "Green Plants" in the centre of a web and brainstormed all they knew about green plants in the following cluster areas: social issues, politics, economics, law, media, global, environment, and technology. After completing the web, students drew lines to connect facts in their web [see Figure 2]. Inevitably students found that all the facts in the web interconnected, and they were asked to make the connections verbally.

This was followed up by "Woolly Thinking" (Pike and Selby, 1988). Students used different colours of wool to illustrate connections among law, politics, technology, and global, environment and social issues. The complex interwoven web of wool was a powerful symbol of interconnection and interdependence. Pulling in one direction affected other factors in the web. This offered a visual way to begin to understand systems thinking.

This webbing activity quickly exposes the North American cultural story, or socio-political-economic context of any topic of study. For green plants, the issue of jobs versus the environment surfaced immediately and was extended to the global situation. It also showed how forces such as media, politics and law are inextricably linked to "green plants." When the web was filled in, students could see that the values represented are materialism, independence, power and oppression. Having students collect newspaper articles over the year reinforced the interconnections in the real world and the values that drive our behaviour and choices.

This new story is a reconceptualizing of humans' role in the living world. The values consciously embedded in the new story are caring for self, others and our planet.

STUDENTS THEN brainstormed for fat and thin questions (Lazear, 1991). We defined a fat question as having many answers, demanding library research and possibly leading to a controlled experiment. A thin question was one whose answer was not complex. Developing the questions was approached from many angles. One activity was to choose current experiments or recent inventions reported in the newspapers. Students generated the

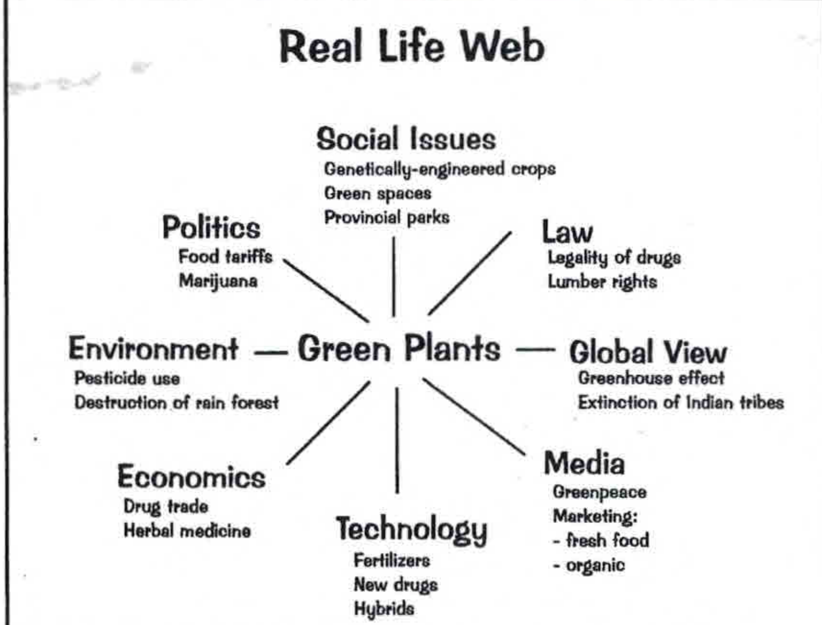


Figure 2: Real Life Webs The topic of study (e.g. green plants) is put in the centre surrounded by politics, law, social issues, technology, environment, media, and global view. Regardless of the topic the web will be filled with interconnections. Typical topics that students might choose for practice are baseball, shopping malls, endangered animals, computers, rap music, houses, telephones, cars, trees, cigarettes, or fish. Looking more deeply to identify values within the web, students find materialism, money, power and lack of caring for the environment at the top of the list.

questions that the researchers must have asked in order to make their discovery.

Another activity we used for developing meaningful questions was bell ringer labs. Here students went through a series of activity labs (as in musical chairs). The purpose was to arouse their curiosity and have them generate questions. At first glance some of these labs seemed to generate thin questions, but students quickly learned that if they brought an inquiring mind to the situation, a fat question was easily generated. For example, the students were presented with a tray filled with water, a long and short candle, and a beaker. They were then asked to generate questions. This appeared simple at first glance, but students learned there was no easy answer: Why is there water in the tray? *Is* it water in the tray? Why are there two candles? Why are the candles different lengths?

From these initial questions students were asked to propose "if...then..." statements or a hypothesis (there was an emphasis on doing this exercise without attempting an explanation). For example, "if I light the candles and put the beaker over both of them, then the candles will go out." Students generated many different predictions. One prediction was selected and the task performed as stated in the "if" part of the statement.

For example, the candles were lighted and the beaker was put over both of them. Students were asked to be astute observers of what happened. At first this elicited qualitative data, and then, as students realized that this was not very useful, they looked for quantitative data. Then another series of questions was generated. Small groups worked on each bell ringer activity and then pooled the data so that the entire class could generate more questions. This was an open-ended activity in which the process was more important than the answer. In fact, the explanation for the phenomena was never made clear.[1]

Students as researchers

ONCE STUDENTS understood the basic concept of developing meaningful questions, they became "students-as-researchers." As a class, they brainstormed for fat questions about green plants. Then students selected one question for a self-directed study. The first step was to go to the library to find current knowledge on the subject. Students were then given a

Thin Questions

How many trees are there in the school yard?
Why is a green plant green?
What gas enters the leaf?
What gas leaves the leaf?

Fat Questions

How do plants move to sunlight?
Why so some plants die in water?
How do plants sense insects?
Why do some plants change colour?
How can some plants survive winter?

Bell Ringer Labs

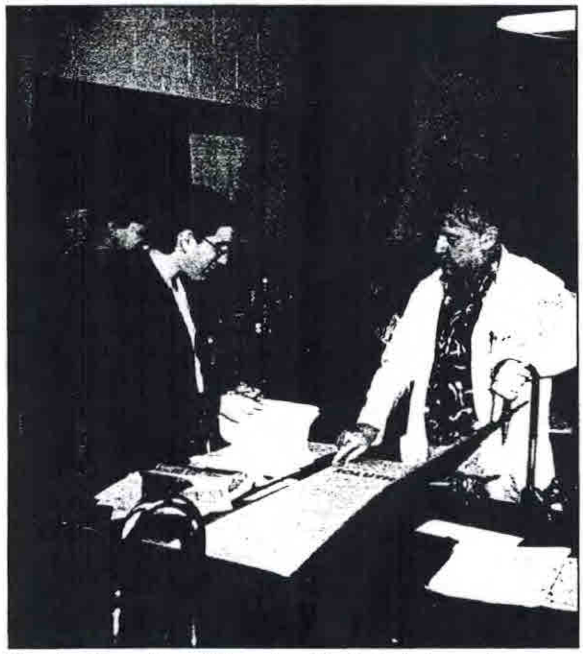
Bell ringer labs motivated students to ask the questions scientists must have asked in order to develop the particle model:

- Using "Joy" detergent, glycerin, strings, jars and water, determine the best recipe for obtaining the biggest bubble.
- Filling bottles with different amounts of water, play a well-known tune. Pay attention to the loudness and pitch.
- Measure the time that it takes for a marble to fall through different liquids. Do marbles move through different liquids at different speeds?
- Is the volume of two separate substances apart the same as together? Use water, sugar, alcohol, and marbles.

written example of a controlled experiment on green plants. This offered a model of what they were supposed to both do and write. Given this, the student was asked to develop a controlled experiment that would address some question that the library research had left unanswered.

One class first did an experiment to see if plants that were serenaded by "Purple Rain" grew better than plants that were not exposed to music. Students "adopted" different plants and periodically measured stem growth, observed the number and size of leaves, and noted changes in colour. This class experiment served as a model for individual at-home projects using a different set of plants.

In another class, pairs of students conducted their experiments in the class over a six-week period. Twice a week a part of the period was devoted to this activity. Fat questions revolved around discovering the optimum amount of water, sunlight, temperature and fertilizer for growing. In one experiment, students compared how plants watered by milk, coke, and orange juice fared. Plants were situated all over the classroom (usually given names by protective students) and could be found in very odd places such as in the cupboard or hanging from the ceiling to see how differing light and temperature affected growth.



Teacher Bruce Hemphill works with students to create environmental storyboards outlining the problem (present story), the cause (old story), and the possible solutions (new story).

The same process was used in the unit on "matter." Again, students selected a question on their own and developed a controlled experiment to answer it. Experiments were done in class and tended towards consumer chemistry: Which is the longest lasting lipstick? What is the best paper towel? Other questions related to the environment: What is the melting point of snow?

The final product was a written report of the entire process. Self-evaluation and peer evaluation were used. Explicit criteria for the final reports were given for these evaluations. We were pleased at the way most students engaged in this task; it seemed most difficult for the "academic" student who wanted a right answer from the teacher.

The mantle of the expert

IN THE SECOND semester, our emphasis on the environment became more direct in a unit called "Does it Matter?" Students from two grade nine classes were brought together as prestigious scientists attending a science symposium. To prepare them for their roles, they were introduced to the "mantle of the expert," a technique of role playing demonstrated by Margaret Burke who teaches drama at Brock University. Students learned that when they were "in role" they were "scientists," not students, and that they were to behave as such. For example, they were to refer to each other as "Dr. ____."

At their first symposium, the students saw a video of themselves answering questions about their attitudes toward garbage. The video had been made the week before when the students had been interviewed by a senior student. The video showed that they knew little about the garbage at Merritton High School and did not care much about it. The question to be explored was then given to the students: what is the amount of "stuff" that comes into Merritton and what happens to the "stuff" that leaves the school in one week? (This was an important difference from when students created their own questions. Interestingly, one dissatisfaction with this unit was that the question had been created by the teachers.)

After the initial science symposium, the classes met separately to decide how they would go about answering the question. The first step was to collect the data for the input and output of "stuff" at the school. The "stuff" was then classified, and students worked in groups to make sense of the data in different categories. This process required many calculations and an understanding of weighted averages. Students learned how to graph their results on the computer using First Graph software.

Several times throughout the six-week unit the two classes met in the science symposium to share new knowledge or listen to an outside expert. For example, Lucy Nigra from the Lincoln County Board Office came in as "garbologist" and gave important information on waste management and data collection. This helped to expand the context from the high school to the community and beyond.

Journals were kept throughout the unit. These were quick reports made at the end of every class that included what they had learned, how they were feeling, and what they still needed to know. These helped us to know how students were responding to the lessons. At times the students were very apprehensive about this unit because they were told that there was not one right answer and not even the teachers knew exactly how to do this. Nevertheless, the journals showed a shift in attitude toward caring for the environment and some commitment to acting as environmental stewards.

The two classes merged to come up with final conclusions, and each group was then responsible for creating and presenting a talking "poster" of their findings. Posters were to be written using the procedures of the scientific method, and computer graphs were to be included. Discussion and reflections were also expected. Students were given a choice of making a video for their presentation or delivering it live.

The posters were presented at a final science symposium to which parents and several "illustrious" guests were invited. Although the students were still expected to be "in role," they seemed to forget this part. The presentations were weak and pointed to a need a need to extend the interdisciplinary skills to include written communication and presentation skills.

Connecting Science with English

TO KEEP OUR major objective but strengthen the presentation skills of students, we joined forces with the English department for a unit of study. Continuing with the student-as-researcher approach, students prepared debates on environmental issues of their choice. Students did real life webbing to see that environmental issues overlapped and were interconnected and interdependent.

The next semester, the science teachers went it alone but used the novel *Ring-Rise, Ring-Set* by Monica Hughes as the vehicle to study science. This science fiction novel provided a setting in which students could explore futuristic environmental issues. It lent itself amazingly well to teaching the scientific content that is typical of the grade nine curriculum.

Stories became more important as students studied the traditional parts of story in the novel study. This was followed by pairs or triads of students choosing a current environmental issue, exploring its root causes and then creating a "new story" in which they were active players. The factual data gathered through independent research was presented on a science story board. One side was devoted to the problem (the present story), the other side to the cause (the old story), while the middle of the board offered the solution, or "new story," and the action the students intended to take to make this story a reality.

These new stories were presented in a format of musical workshops. Small groups of students rotated through the workshops and asked fat questions of the presenters. The afternoon was an unqualified success. By their ability to address the questions that other students asked, students demonstrated that they really understood the concepts they had been learning and researching. It was satisfying to note that students could now both ask and answer meaningful questions. As well, it was clear that the presentation skills of students had improved dramatically using this format.

This was a beginning of integrating science with other subjects to make it more meaningful and relevant. There seems to be a natural fit for English in the science department. Next year we will rejoin forces with the English department. They will teach the novel while Science will work on creating new stories through the science lens — allowing more time to focus on the storied aspects of our lives.

HOW HAD WE fared in achieving our major outcome that students be able to ask a meaningful question and answer it systematically while honouring the environment? We realized that in order to accomplish our outcome we had actually taught several of the following interdisciplinary skills:

Real Life Webs: *Making connections, systems thinking*
Fat And Thin Questions: *Developing meaningful questions*
Library Research: *Information management*
Controlled Experiment: *Problem solving*
Data collection: *Classification, surveying, graphing, analysis*
Journals: *Reflection*

We had not lost the integrity of "science" by focusing on these skills. Basic scientific knowledge had been the vehicle, yet English, math and computer skills had been a large part of the process. We realized that the "values" outcome of this course (to act in ways that value the environment) could not be measured objectively or even immediately. The real outcome would be demonstrated by consistent behaviours over years to come. Yet we all felt strongly that we must not only continue to emphasize becoming a green school, but that we must continue to stress creating a new "green" story to live by.

Susan Drake teaches at Brock University and Merritton High School in St. Catharines, Ontario. **Bruce Hemphill** and **Ron Chappell** are science teachers at Merritton High School.

Notes:

[1] We challenge anyone curious about the burning candle phenomenon to try the experiment. The result will always be the same, but we know at least five equally plausible explanations. The challenge is to go through the process of asking meaningful questions in order to develop more than one reasonable answer.

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