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ABSTRACT

This paper initially presents the results of several studies concerning what kind of writing science teachers assign and what kind of writing science textbooks assign. By far, reporting was the most popular type of writing assigned in the surveyed textbooks, although other types of writing were in evidence. Exposition tended to take three forms: explaining a concept; discussing a concept; and writing a letter to an agency for further information. Three-sample paragraphs from science content writing are presented. Several teaching strategies are delineated and it is suggested that teachers try to make students aware of the reading, thinking, and writing which the topic demands; give students diagramed model paragraphs to show how ideas relate; and encourage students to compose and not copy by basing the assignment on more than one source, controlling the source, and conducting paraphrasing exercises in class. (TS)

SCIENCE TEXTBOOKS AND THE TEACHING OF ASSIGNED WRITING

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Many of us today are willing to accept the idea that reading instruction doesn't stop at the primary grades, that, in fact, it continues on through high school and even into college. Every teacher, a content specialist, can be perceived as one who can teach his or her students how to read the assigned textbook. Isn't the same thing true for writing? If content area teachers are the most appropriate ones to teach students to read texts, would they not also be the most appropriate ones to teach the content area writing that they or their textbooks assign?

Science Teachers Do Assign Writing

A recent survey (Donlan, 1974) indicated that teachers in all content areas assign writing, including science teachers. Over half of the science teachers surveyed assigned some sort of writing other than essay tests and short answer questions. In fact, four types of writing were assigned: narration (43% of those surveyed), exposition (36%), argumentation (14%) and reporting (86%), even though there was a tendency for these writing assignments to be short (300 words and under) but frequent (10-12 per year). Generally, these surveyed science teachers tended to assign writing both as an extension of class work and as extra credit or enrichment. And although 43 percent of the surveyed science teachers felt that writing was the responsibility of the English teacher,

71 percent felt that this responsibility should be shared by the content area teacher.

Science Textbooks Also Assign Writing

Certainly the small population of surveyed science teachers is an inadequate sample on which to justify the teaching or assigning of composition in science classes; the sample was a subset drawn from 123 teachers from a large metropolitan area. However, there was evidence that some mathematics teachers assigned, and sometimes taught, writing in the content area of science.

One might logically question the type of writing appropriate for a class primarily focused on quantitative and empirical skills, not verbal skills. A survey of recent science textbooks can supply specific types of assignments that can be made. Out of 29 science textbooks housed at the two curriculum centers at UCR, 13 listed writing assignments that required composition skills (see Appendix for a list of texts). Table 1 indicates the number of writing assignments by text by writing type.

Table 1. Writing Assignments/Science Text/Writing Type

Text	Grade Level	# of Assignments	Type: Report	Exposition	Narration	Argumentation
1	7 8	28	27	1	0	0
2	7 8	3	3	0	0	0
3	7	10	10	0	0	0
4	8	10	10	0	0	0
5	7 8	13	13	0	0	0
6	8	2	1	1	0	0
7	9	1	1	0	0	0
8	7	1	1	0	0	0
9	7	24	18	5	1	0
10	7	7	6	0	1	0
11	8	8	6	1	1	0
12	8	23	22	1	0	0
13	7	26	25	0	1	0
	8-7-1	156	143	9	4	0
$\bar{X}$		12	11	.7	.3	0

Types of Writing/Content of Writing

Of the 155 assignments, 143 required "reporting" as the mode of written response. Of these 143, 91 included the directive "Report on" or "Write a report on . . . .": e.g., "Report on the Co-Magnon Cave of France. . . ," "Report on the latest solar eclipse," and "Write a report on the conservation measures used in your community to keep the water

clean." 52 assignments did not use the word report but asked the student to perform operations that were equivalent to reporting: summarizing, recording, listing, obtaining information, and writing a paper on a topic.

By far reporting was the most popular type of writing assigned in the surveyed textbooks. However, other types of writing were in evidence. Students were asked to engage in exposition in 9 separate instances. Exposition tended to take three forms: (1) explaining a concept, (2) discussing a concept, and (3) writing a letter to an agency for further information. In addition, there were four instances where texts assigned narrative writing, generally science fiction stories built around content in the chapter.

Table 2 presents data on types of writing in terms of total assignments and percentages.

Table 2. Frequency and Proportion of Various Types of Writing Assigned in Science Textbooks

Type	Sub-type	# of Assignments	% of Total N
Reporting		143	92
	Report	91	58
	Summary	31	20
	Record	1	.6
	Write paper	2	1
	List	16	10
	Obtain information	2	1
Exposition		9	5.2
	Letter writing	7	4
	Explaining	1	.6
	Discussing	1	.6
Narration		4	2.6
	Story writing	3	2
	History narrative	1	.6

Assigning vs. Teaching Writing

Although an examination of the thirteen science textbooks indicates that writing is assigned, there is only scant evidence to indicate that writing is, or should be, taught. For example, out of 156 assignments, there are only 45 instances where "helps," or enabling suggestions are made. The most common type of help tends to be an outline for the students to follow. In one instance, guide questions were provided (e.g., "What conditions were tested? What were the results?"). Where students were asked to write letters, addresses were provided. On several occasions, general suggestions were made as to the form of the paper: e.g., illustrate with drawings, give report orally to class. Although the enabling suggestions were helpful, they might have been more extensive.

Modes of Discourse

In examining Tables 1 and 2, one can see that students in science classes are asked by textbook writers to write reports. However, "reports" is a vague concept. When a teacher assigns the writing of a report, s/he generally wants the student to do outside reading from several sources and compile or synthesize the data into a coherent report, his perception is different from that of his teacher: s/he will read secondary sources and summarize, generally copy, the findings. The result is that the teacher is frustrated by the lack of quality in the final product and the student is perplexed by lack of direction.

Reporting covers a variety of writing types and styles. Some of the reports are really biography: "Report on the lives of Pierre and Marie Curie." Some reporting historic facts: "Report on the latest findings concerning man's early history which suggest that Africa was

his place of origin." Some reports demand analysis: "List at least 15 lithospheric materials which you have observed in use in your home. Tell where you saw each material used." Many reports are summaries of processes: "Prepare a report on the quarrying of marble, limestone, slate or ganite" and "Report on the effect of wind on Cape Code, Cape Hatteras, and Padre Island on the Gulf Coast." These are only four separate modes of thought and discourse under the rubric "report." Each mode demands a different organization, perhaps even a different paragraph structure. Consider these paragraphs from science content writing:

(1) Biography

> More than any other scientist, the American inventor Lee DeForest was responsible for the basic developments which underlie the science and technology of modern vacuum tubes. In 1883 Edison showed that an electric current (now called the Edison effect) could exist between a heated filament and a metal plate, both enclosed in a vacuum. In 1904 the English physicist John Fleming found that such a two-electrode vacuum tube (diode) could detect wireless signals. When DeForest finished his doctoral degree at Yale, specializing in radio waves, he resolved to excel in the new field of wireless communications. To the basic diode vacuum tube DeForest added a third electrode, which could control the magnitude of current between the other two. This control electrode eventually took the form of a zig-zag grid of wire between the hot filament and the cool, metal electrode.
>
> DeForest sought to develop a business enterprise on the basis of his vacuum tube developments, but he was less successful as a business organizer than as a pioneer in electronics. In the early years the usefulness of his triode was severely ridiculed. In 1913 he tried to sell stock in a long-range communication system which used the triode, and he was actually brought to trial for fraudulent use of the mails. The prosecution argued (unsuccessfully) that the triode was a fake and would not really work. Yet two years later the triode was successfully used for radiotelephone communication between Virginia and Paris and between Virginia and Honolulu. Eventually the American Telephone and Telegraph Company purchased the patent right to many of DeForest's inventions. (Robert Stollberg and Faith Fitch Hill, Physics: Fundamentals and Frontiers. Houghton Mifflin Company, Boston, 1965, 507).

(2) Summary of Process

Sunlight travels a distance of 93 million miles at a speed of 186,000 miles per second before it strikes the earth. Without sunlight, life could not exist on this planet. Light also affects the behavior of most plants and animals, including man. Most of us, for example, regulate our activity by the sun, working during daylight hours and sleeping during the night. Many kinds of insects are attracted toward light. If you leave a door or window open in your house on a warm summer night, you know that many small insects soon will be flying around the lamps inside. Some insects and other animals move away from light. Early man discovered that the light from his fire would keep animals away at night. (Norman Abraham and others, Chicago: Rand, McNally and Company, 1973, p. 278).

On the surface, the three paragraphs appear to be similar in that they report science content. However, a closer examination of the paragraph (after Christensen, 1967) indicates that the paragraphs have different arrangements of ideas.

(1) Biography

Main Idea

1. More than any other scientist, the American inventor Lee DeForest was responsible for the basic developments which underlie the science and technology of modern vacuum tubes.

Subordinate to 1

2. In 1883 Edison showed that an electric current (now called the Edison effect) could exist between a heated filament and a metal plate.

Coordinate Ideas

2. In 1904 the English physicist John Fleming found that such a two-electrode vacuum tube (diode) could detect wireless signals

2. When DeForest finished his doctoral degree at Yale, specializing in radio waves, he resolved to excel in the new field of wireless communications.

3. To the basic diode vacuum tube DeForest added a third electrode, which could control the magnitude of current between the other two.

4. This control electrode eventually took the form of a zig-zag grid of wire between the hot filament and the cool, metal electrode.

Subordinate to 2.

Subordinate to 3.

The first sentence appears to be the most general sentence in the paragraph; it is considered the main idea and is indicated as a level 1 (general) statement. Following the first sentence are three level 2 sentences that are subordinate to 1, since they elaborate on the phrase "more than any other scientist" by mentioning Edison, Fleming, and finally DeForrest. Notice that of the three level 2 sentences only the third is expanded upon: the phrase "added a third electrode" is subordinate to "he resolved to excel" and, in turn is subordinated by the level 4 sentence "This control electrode . . . metal electrode." The first paragraph is said to have general to specific movement, with the topic being penetrated to a fourth level of specificity. Now examine the second paragraph from the DeForest biography.

1. DeForrest sought to develop a business enterprise on the basis of his vacuum tube developments; but he was less successful as a business organizer than as a pioneer in electronics.

2. In the early years the usefulness of his trade was severely ridiculed.

3. In 1913 he tried to sell stock in a long-range communication system which used the triode and he was actually brought to trial for fraudulent use of the mails.

Main Idea

... ordinate ideas

Subordinate to 2.

Subordinate to 3.4. The prosecution argued (unsuccessfully) that the triode was a fake and would not really work.

2. Yet for years later the triode was successfully used for radio-telephone communication between Virginia and Paris and between Virginia and Honolulu.

2. Eventually the American Telephone and Telegraph Company purchased the patent right to many of DeForest's inventions.

Notice that, like the first paragraph, the topic is penetrated 4 levels of specificity and there are 3 level 2 sentences that are subordinate to the main idea. However, the movement zig-zags from general (1) to specific (4) to less specific (2).

If students write biographical reports, they will do well to penetrate the topic 4 levels. What often happens is that the student only write levels 1 and 2 sentences, as in this paragraph.

Main Idea 1. Fermat, Pierre de (1601-1655), a French mathematician, won fame for his work in the theory of numbers or integers.

Main Idea 1. He also shared in the invention of analytic geometry and calculus.

Main Idea 1. He formulated the least-time law to explain the diffraction (bending of light, and also developed an equation for the graph of a straight line.

Main Idea 1. His "last theorem" has never been proved or disproved.

Subordinate to 1.

2. Fermat knew integral solutions of the equation $x^2 + y^2 = z^2$ (for example, $3^2 + 4^2 = 5^2$).

coordinate ideas

2. His theorem held that there was no whole number solution of $x^n + y^n = z^n$ if the exponent, n, is larger than 2.

Main idea

1. Fermat, along with Blaise Pascal, is credited with originating the theory of probability now widely used in insurance and statistics.

Main idea

1. Fermat practiced law in Toulouse and studied mathematics only as a hobby.

Main idea

1. He was born in Beaumont-de-Lompagne.

Providing the students with model paragraphs, diagramed, can help them see what is expected of them when they write reports. It will also show them varieties of organization patterns in science writing.

Here for example is a fourth example of science content writing:

Summary of Process

Main Idea

1. Sunlight travels a distance of 93 million miles at a speed of 186,000 miles per second before it strikes the earth.

Subordinate to 1.

2. Without sunlight, life could not exist on this planet.

Subordinate to 2.

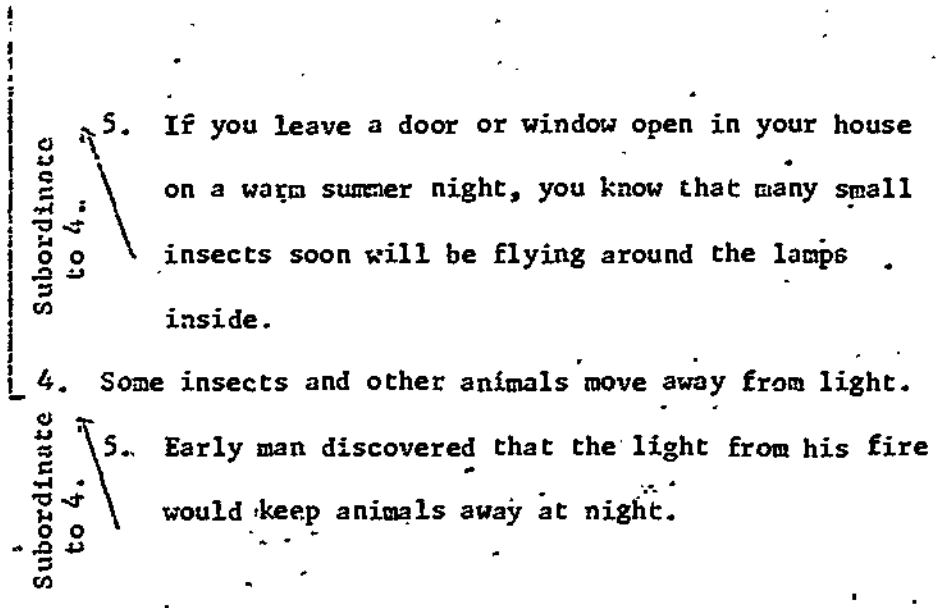
3. Light also affects the behavior of most plants and animals, including man,

Subordinate to 3.

Coordinate Ideas

4. Most of us, for example, regulate our activity by the sun, working during daylight hours and sleeping during the night.

4. Many kinds of insects are attracted toward light.



Writing from Text, Not Copying.

If it is understood that (1) reporting includes many modes of discourse--biography, history, summarizing process--and (2) more precise guide words (list, discuss, show causes and effects) can give students a clearer understanding of what they are to do, the science teacher's problem is to keep students from copying directly from encyclopedias, or other secondary/tertiary sources. By copying, students are not in all probability learning any content and they might as well xerox the source, hand it in, or read from it. Both mastery of content and acquisition of writing skill would best be served if the assignment were made in such a way as to preclude copying. Here are some methods for ensuring original writing:

The science teacher might--

1. Base the assignment on more than one source so the student will have to assimilate the material.
2. Control the sources, that is, limit the references to a few sources that every student has access to; even xerox the sources for the entire class.

3. Conduct brief paraphrasing exercises in class in which students synthesize two sentences relating identical or similar content into one original sentence.

Conclusion

This article is not intended to defend writing as part of the science curriculum. However, the author has noted that some science teachers and some science textbooks assign writing as an extension of classwork. If writing is assigned, it might also well be taught. Several teaching strategies that are not time-consuming would ensure higher quality writing and, thus, more effective learning:

1. Make the student aware of reading, thinking and writing the topic demands.
2. If possible give students mode paragraphs, diagramed, to show how ideas relate in, for instance, biography and process summary.
3. Encourage students to compose, not copy, by (a) basing the assignment on more than one source, (b) controlling the source, and (c) conducting paraphrasing exercises in class.

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