WRITING ASSIGNMENTS— PATHWAYS TO CONNECTIONS, CLARITY, CREATIVITY*

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The processes of writing and learning are fundamentally and powerfully linked. Fulwiler (1987a) asserts that "writing is basic to thinking about, and learning, knowledge in all fields as well as to communicating that knowledge." Elbow (1986) concurs, observing that writing leads to more detailed and complete thinking as the writer explores connections and different organizational patterns in the material to be learned. Adherents of the Writing across the Curriculum movement (Young and Fulwiler 1986, Fulwiler 1987b) have cited substantial benefits of writing assignments in facilitating learning, especially in subject areas like science and mathematics that do not normally involve such assignments.

An additional potential benefit of writing assignments has to do with what Marton (1975) calls *surface* and *deep* approaches to learning. Many college teachers are frustrated by the tendency of most of their students to take a surface approach, meaning that they pursue their studies with a minimum of personal engagement, satisfied to memorize facts and problem-solution procedures without attempting to understand them. Only a small minority routinely adopt a deep approach—wherein they try to understand rather than just to memorize—delving into the meanings of lectures and readings, asking probing questions, voluntarily doing outside reading, and relating class material to material in other subjects and to their own experience.

Most of us would prefer that our students adopt a deep approach to learning—but how do we get them to do that? We can of course advise them to do it, assuring them that it is for their own good, but we all know how futile such advice tends to be. Fortunately, certain instructional methods have been shown to promote the deep approach to learning, notably making students aware of the relevance of the subject matter to their lives and interests and assigning a variety of learning tasks that require them to deepen their thinking about the subject (Entwistle 1988, Ramsden 1988). Writing assignments can be ideal vehicles for meeting these conditions. They can be used in any class on any subject. Such assignments may help students to seek and find applications of new material to problems in other courses, disciplines, and their personal lives; and to think critically and/or creatively about whatever they are being taught. The assignments may be in-class or take-home, convergent or open-ended, done by individuals or pairs or teams of students, taking periods of time from one minute to an entire semester.

In our classes we have assigned a variety of writing tasks that vary considerably in scope, objectives, and required level of instructor involvement but have in common a grounding in cognitive theory (Gagne 1985, Perry, Mouton, and Reigeluth 1987) and a demonstrated ability to enhance students' interest in the course material and to facilitate their learning. These assignments are designed to stimulate students to (1) explore their initial attitudes toward the subject to be studied; (2) activate their prior knowledge about the subject; (3) perceive the relevance of the subject to their lives and interests; (4) clarify, organize, and summarize course material; *(5)* establish mental connections between newly learned and previously known material; (6) improve their critical thinking skills, and (7) develop and strengthen their creativity. The assignments are given in italics with interspersed notes that explain their educational functions and, when appropriate, their role in motivating a deep approach to learning.

Exploring Initial Attitudes

Because students' initial attitudes toward a course can affect their willingness and ability to learn the course material, instructors and students can benefit by becoming aware of those attitudes from the outset. A good way for the instructor to promote this awareness is to ask the students to write about their feelings as they begin the course.

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What have you heard about this course? What are your feelings about starting it? What grade do you expect to get in it?

A related assignment encourages students to explore their feelings about a difficult or sensitive aspect of the course.

What was it like when you first learned to read (use the computer, solve word problems, dissect, deal with an emotionally disturbed child)?

Before beginning a segment on reading readiness in a developmental reading class, one of us asked the students the question about learning to read. They responded with a broad range of difficult, embarrassing, and successful experiences; subsequent sharing of their writing enhanced both their understanding of the topic and their readiness for the course material.

Activating Prior Knowledge

Psychological research has shown that learning does not take place in a vacuum; rather, people learn by assimilating new information into existing cognitive structures (Gagne 1985). Stimulating students to recall things that they already know that are related to the course material can substantially increase the likelihood of their success in learning new concepts.

Briefly summarize what you know about pre-Freudian psychology (vapor-liquid equilibrium, influences on Cezanne, geometrical proofs, the concept of personal space).

List at least three problems that commonly arise in classroom management (two methods used to compare sample means of two populations, five principal causes of World War II, four systems in your everyday life that involve flow of fluids through closed channels).

An effective way to stimulate students to tap into what they know and pinpoint what they do not yet know or understand about a subject is to ask them to generate a list of questions.

List seven questions or things that you don't know about the Renaissance (special relativity, language acquisition, stuttering in young children, cell growth). For each question you list, indicate why it might be important to know the answer.

Once generated, the list provides motivation and focus for learning the material to be taught. An even deeper level of thought about the material may be induced by asking the students to predict the answers to some of the questions.

Increasing the Relevance of the Subject

An apparently necessary condition for most students to adopt a deep approach to learning is that they perceive the relevance of the subject to their lives. Perhaps the most effective way to establish relevance is to get the students to do it for themselves.

List situations in your life when you have had to (when you might need to) estimate a quantity (speak before a group, write a set of directions, use mathematics outside of the classroom).

Clarifying, Organizing, and Summarizing Course Material

As the course proceeds and students are presented with additional information, they need opportunities to reflect on the new material. Writing assignments can be effective vehicles for providing such opportunities. Moreover, in every class there are instances when students become confused by the volume of new information or when the class wanders off the subject. At such times, writing can be a powerful refocusing technique.

Review what you know at this point about the origins of our present two-party system (solar energy, leading economic indicators, data-base structures, recurring themes in Shelley's poems, the structure of the periodic table). What points or questions would you like to discuss further?

Look back at the questions that you listed before we began this topic. Are there any to which you still don't have answers? Why might it be important to get the answers? How might you go about getting them?

After completing such assignments, the students generally have a much better understanding of the ideas presented up to that point in the course and are also more receptive to new information. In addition, after completing the assignments, the students tend to contribute more freely to class discussion: even students who do not usually volunteer in class find things to say when they have had some time to reflect and organize their thoughts. The material they are asked to review may be cumulative, as in the above examples, or more immediate, as in the next one.

Prepare a one-sentence (one-paragraph, one-page, one-minute) objective summary of the main ideas in (the content of) this article (chapter, class period).

Some instructors routinely have students write summaries of what they have learned in a class session and submit them before leaving. By scanning the comments from all the students (or from a subset in a large class), the instructor can quickly determine whether the students grasped the material. This knowledge can clearly be useful in planning for the next class meeting. Short-range review assignments can be particularly valuable in science, mathematics, and engineering courses, in which students who favor surface approaches tend to ignore their textbooks and lecture notes, except to hunt for examples that show them how to solve the homework problems. Requiring these students to summarize in writing the material presented in readings and lectures stimulates them to pay attention to their text and notes.

Establishing Connections between New and Previously Known Material

A deep approach to learning involves relating new material to that previously known from experience or formal education (Marton 1975). Writing assignments can train students to seek these connections.

List as many connections as you can think of between reading and writing skills (analysis of variance and t *tests, what you have learned so far in this course and in Economics 203, Bloom's cognitive levels and current world events, the law of supply and demand and your family, quantum mechanics and your life).*

Motivation to delve deeply into a subject is particularly enhanced if the students are reminded of the potential usefulness of the material.

List all the practical applications you can think of for complex variables (familiarity with Shakespeare, Maslow's hierarchy of needs, Maxwell's relations).

Improving Critical Thinking Skills

Critical thinking is the process of examining and analyzing information and drawing and justifying conclusions regarding its validity. Critical thinking skills include abilities to draw sound inferences from observations; evaluate credibility and reliability of sources; identify main ideas, underlying assumptions, and logical fallacies; synthesize ideas and interpretations; develop cogent arguments in support of the validity or plausibility of a thesis; and generate new questions or experiments to resolve uncertainties (Kurfiss 1988). Critical questions about a particular reading or lecture address unstated assumptions, aspects of the topic not taken into account, or unsubstantiated conclusions. A characteristic of a deep approach to learning is a tendency to raise critical questions about everything, including (and perhaps especially) conclusions drawn by such authorities as the textbook author and the course instructor.

These thinking skills are as teachable as skills like reading, solving differential equations, and riding a

bicycle; like all skills, however, they must be modeled by instructors and practiced before they can be mastered. Writing assignments may be the best vehicles for providing that practice.

Analyze and evaluate the chapter/article you just read (the lecture I gave today, the speech the president is scheduled to deliver tonight, the lead editorial in tomorrow morning's paper).

Write a one-paragraph (one-page, three-page or less) objective summary.

Formulate at least five critical questions.

Draw conclusions about the validity or invalidity of the point of view of the author (speaker) and present arguments in support of your case.

Outline a procedure you might follow (interviews, experiements, etc.) to determine the validity of your *conclusions.*

Felder and Soloman (1988) describe an interdisciplinary freshman course called "The Systems View of the Universe," based almost entirely on writing assignments of these types. The students invariably begin the course intrigued or puzzled by what they are being asked to do. They then go through a period of frustration and sometimes hostility as their summaries and critical questions keep coming back with the equivalent of "Nice try, but not quite there yet," along with specific constructive suggestions. As the course progresses, they gradually start to catch on, and by the end of the semester many of these freshmen are thinking critically at a level rarely attained by seniors.

Developing and Strengthening Creativity

A popular myth is that creative thinking and problem-solving skills cannot be taught—either one has them or one doesn't. Decades of research (see references cited by Torrance and Rockenstein 1988) refute this notion, showing instead that while creative potential may vary from one individual to another, creative thinking is another teachable skill that can be developed and enhanced by practice and feedback. References on creativity, for example, Adams (1974), deBono (1976), and Rubinstein (1986), suggest many general creativity exercises, and Felder (1987, 1988) offers specific ideas for technical courses.

List three ways (ten ways, as many ways as you can think of) to evaluate economic profitability (measure the viscosity of a fluid, deal with a disruptive student in a class, injure yourself when running the next experiment in this lab).

Suppose we build the bridge (perform the test, run the experiment, apply the treatment, teach the lesson) the wav our theoretical calculation indicates we should, and the result we get is not at all what we predicted. List as many possible explanations as you can for the unexpected findings. Then prioritize the list in order of decreasing likelihood and indicate how you might go about tracking down the real cause.

The latter exercise requires the students to think about virtually every aspect of the subject—possibilities for experimental and computation errors, invalid assumptions, factors that were not taken into account by the theory, and so on.

A particularly powerful assignment to facilitate deep thought about a subject is the problem definition exercise, in which students are requested to make up problems that could be used in homework assignments or on tests. Many instructors have devised such exercises for their classes; however, if the exercise is improperly structured, students who are inclined to adopt a surface approach to learning will simply construct superficial problems, and the point of the exercise will be lost. One technique is to explicitly require the students to make up questions that call for the application of Bloom's (1967) higher-level thinking skills of analysis, synthesis, and evaluation.

Make up (or make up and solve) a problem (test, final examination) on the material in this course. Note: If your problem(s) can be answered by simply looking things up or plugging directly into standard formulas and procedures, you will get at best a barely passing grade. To

earn full credit, you may require the problem solver to use analysis that goes beyond what we have covered in class and/or to use material from other subjects (the more apparently unrelated the better). The problem(s) should also require some evaluation—not just determining a single correct answer but generating a list of alternatives and deciding which alternative is the best one, most economical, safest, most environmentally sound, etc.

Felder (1985) describes what happened when he asked his students in a first-year graduate course on chemical reactor analysis to construct and solve a final examination along these lines. After going through an initial period of uncertainty and fear when confronted with the assignment, they developed an impressive assortment of examination questions. Problems involved material from other engineering courses, chemistry, biology, advanced mathematics, food science, environmental engineering, and personal and corporate ethics. One student formulated a mathematical model of human achievement fashioned after a similar model of chemical reactions in a spherical catalyst particle. Another developed and critiqued a kinetic model for pair formation in a singles bar. Yet another came up with a complex model for the relationship between predators and their prey, which was good enough to be published (and subsequently was).

Our conclusion is that students are capable of a great deal more creativity than anyone thinks they are; the only reason that they do not normally show it is that no one asks them to. Writing assignments that call for creativity will elicit it from many students; repeated assignments of this type coupled with constructive feedback will improve the creative skills of *all* students.

Donald Graves (in Fulwiler 1987a) asserts, "Writing is the basic stuff of education. It has been sorely neglected in our schools. We have substituted the passive reception of information for the active expression of facts, ideas, and feelings. We now need to right the balance between sending and receiving. We need to let them write."

Suggestions for Using a Variety of Writing Assignments

- Don't set out to do it all at once. Start by trying one or two of the suggested assignments that appeal to you; then gradually add new ones to an extent that seems appropriate and comfortable.
- Clearly relate the assignments to the course content, and be sure students understand the connections.
- When you decide to use a particular type of assignment (e.g., brainstorming, critical question generation, problem formulation), try it at least three times. The first time that you ask students to do something unfamiliar they are likely to ignore you, as though not believing anyone could want them to do anything that bizarre. The second time they will take the assignment seriously, but many will miss the point. By the third time, you will start to see the sought-after results.
- All of the given writing exercises may be completed in or out of class. In either case, set aside class time for brief sharing and discussion of the responses in groups of three to five. Such discussions expose the students to a wider variety of ideas than most could have thought of individually and reduce or eliminate the need for the instructor to read and critique all the papers.
- Many of the suggested assignments require no feedback from the instructor; the process is more important than the product. But for those assignments that do result in a product (make up a problem, develop critical questions), make sure that the students get constructive feedback on their initial efforts, including suggestions on how they could have done it better. The feedback may come from you (initially it will have to), but the students may also provide it to one another after they have gained some experience and understand the object of the exercise.
- Ask students to evaluate particular assignments and the writing experience as a whole. Make changes in assignments that do not seem to be accomplishing their objectives.
- Write articles about assignments that work particularly well so that other teachers can get the benefit of your experience.

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