Instructional Strategies That Never Fail Us

Bringing Students' Creativity into the Science Curriculum

Abour H. Cherif

My colleagues and I have composed and applied some instructional strategies for teaching which we feel can benefit teachers and students of science. So that readers may understand the environment in which these methods were applied, and to help you consider how you may want to adapt these ideas for your institution, I would like to give a brief summary of the nature of the establishment where I work, and an introduction to the kind of students and courses I have been teaching.

Columbia College, Chicago, is an urban-centered art, media, and communications college. Its open admissions policy guarantees teachers will encounter a variety of experiences and abilities in the student body, reflecting multiple social, ethnic and class backgrounds. The faculty is composed of part-time professionals who teach in their area of expertise and full-time academics. This instructional blend provides over 7,000 students with academic and professional training and real-world experience. The faculty and staff of the science and mathematics department offers more than 50 different science and mathematics courses each—most designed specifically for art and communications students. These courses were developed using a variety of teaching approaches such as the inquiry method, role playing, laboratory experiments, inductive thinking, and collective writing.

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STUDENT-CENTERED INSTRUCTIONAL STRATEGIES FOR CLASSROOM TEACHING AND MANAGEMENT

All students are capable of successfully learning science. However, we must be aware of students' learning styles and instructional preferences, and we should be willing to give them various opportunities that nurture their learning productivity. To help ensure this, for example, I create balance in group discussions by sorting students by gender, race, and academic abilities. Initially the students are reluctant to participate in groups, but soon they grow to anticipate these exercises. Following are some ideas on how to spark enthusiasm for group exercises.

SAVINGS ACCOUNT

Just like in a bank, the "Savings Account" method allows students "deposits" and "withdrawals," as it were, in the form of "credits receivable." In order to keep their accounts open, students must create a minimum balance of three accepted assignments. From this point they have the opportunity to deposit additional assignments as extra credit toward their final grade.

To set up the accounts, the instructor gives the students a list of topics selected from sources such as daily newspapers, magazines, a book chapter, or a published paper on a particular lab activity. Students are required to submit a list of their research materials and a written summary on their preferred topic within the range provided.

Examples of the topics students have chosen are: the historical roots of biotechnology, the new development in gene therapy, the story of the periodic table of elements, and public

opinions about the definition of life. The student's extra work is evaluated and graded based on his or her ability to: (a) identify a problem and gather related information, (b) organize and analyze the gathered information, (c) suggest a well thought-out solution to a problem based upon known information, (d) make critical inferences that explain his or her findings.

The work will also be evaluated on how well the final report is written and presented in the classroom. The student is informed of his or her grade and advised, if necessary, on what he or she might do to improve his or her work. Criteria for evaluating this report can be found in many instructional books on how to write science term papers.

Finally, the student who turns in three extra assignments can choose the best grade of the three to count toward 5 percent of the final grade. If a student does five extra accepted assignments, then he or she can choose the two best grades out of five, counting toward 10 percent of the final grade. If a student has done less than three extra assignments two weeks before the end of the semester, his or her account will be closed.

A Free Classroom Creative Assignment

Once every semester I give students the opportunity to demonstrate their understanding of a given scientific concept using the medium of their choice—thereby encouraging them to use their creative forte. In this Free Classroom Creative Assignment, students may create cartoons, songs, poetry, a play, or even perform a dance about topics such as cell division, atoms and molecules, and mitosis.

This project is special in that it allows teachers to really discover the essence of their students' artistic personalities. The more teachers know about their students, the more effective they will be in relating to them. By giving students the freedom to express their understanding in non-traditional methods, you are giving them the opportunity to unveil the multi-dimensions of their personalities. (If a creative assignment is too lengthy to perform during the class, then an hour is reserved when most of the class can attend.)

High Standard Term Paper

The High Standard Term Paper is accepted as "A" level work only. The student must produce a well-written paper about an agreed-upon topic to count for 10 to 20 percent of the grade. The instructor evaluates this paper based on criteria such as cognitive ability, content, argument, syntax, and usage. If on the first try it is not accepted as an "A" paper, the student gets two weeks to rewrite. If not accepted on the second try, then the student is given another week to rewrite. If the student turns in a third rewrite and still does not receive an "A," he or she is given a final week to rewrite. If the student fails to produce an "A" level term paper by the end of his or her fourth rewrite (which is rarely the case), then an exception is made and the student is given the grade his or her paper received on the second try.

Examples of the students' term paper topics include: the effect of the Gulf war on marine life in the Gulf region; whether or not biotechnology can save us from the AIDS virus, and hazardous waste disposal. The writing center, the science and math learning centers, and the resource center of the science and math department of Columbia College are available to aid students with this project.

Collective Writing

In the Collective Writing method, all students are given the same assignment which usually deals with a controversial topic such as animal testing in science labs, HIV tests in the health profession, or genetic engineering. The class is divided into groups of four. Individually, students spend one week gathering information and writing an outline for their assignment. The groups then meet during class to brainstorm, compare and modify outlines, and generate a list in question format of issues of concern. The groups then collectively write the first paragraph of their writing assignment. The final draft of the first paragraph, which is also written collectively, must be used by every student in the group. One week later, the groups meet to compare their conclusions and rewrite the final paragraph. The student's individual and group conclusions are maintained in the written assignment. Thus, the instructor receives four written assignments with the collectivelywritten first and last paragraphs, but with the body of the paper written individually.

A colleague of mine successfully applied a variation on the collaborative writing assignment in which a group of three students developed a three-part thesis and incorporated it into an introductory paragraph. Each student researched and wrote one section, then collaboratively incorporated the three sections into one paper. This method involves a lot of revising and works best in a computer-assisted classroom.

Reenacting a Scientific Interview in the Classroom

In this instructional strategy, students reenact a recently published interview with a prominent scientists or a world leader. I usually bring to class copies of interviews published in the *American Biology Teacher Journal* (*ABT*), and/or the *Calypso Log: The Cousteau Society Journal*, another rich resource for interviews with various scientists and world leaders (see Table 1 for more examples).

Students are divided into groups of three; one member acts as the scientist, another the interviewer, and the third as a reporter who, at the end of the interview, gives an oral report on the most important aspects of the discus-

sion. The interview and the summary usually take between 15 and 20 minutes, necessitating that students select only the most pertinent information. At the end of the summary, the interviewer asks the class two questions about the interview and students hand in the answers to the instructor the following week.

Some students prefer to invent their own interviews using available information about the person to be interviewed. For example, one group constructed an interview with writer, producer, and philosopher Gene Roddenberry, the creator of "Star Trek" and "Star Trek: The Next Generation." The students examined the genetic information from several episodes of these two programs, and then modified an existing interview with Mr. Roddenberry by David Alexander (1991), to include this information. Finally, one student took on the role of Gene Roddenberry, the other of David Alexander, and the third acted as a reporter.

A very creative "interview" was staged by a group using both Randy Moore, editor of *ABT*, and one of his major writers in the journal, Professor Maura Flannery. The students pretended the two had met for lunch (they actually did eat lunch in the classroom) and discussed the history and new developments in biological sciences. Instructors will find *Earth Ethics Journal* (published by Center for Respect of Life and Environment), a rich resource for constructing interviews.

Letters To The Editor As An Instructional Strategy

Editorials and letters to the editor about articles or issues in scientific journals enable instructors and students to stay informed and updated about controversial topics, philosophical differences, research findings, and new discoveries. They also help instructors and students to develop an interdisciplinary perspective, thereby cultivating critical analysis.

Through instructional strategies such as these we try to give students alternative opportunities to maximize their learning productivity and to help them become more inquisitive, willing to take chances, and become more appreciative of science, art, mathematics, and humanity.

I prefer letters which criticize articles in *The American Biology Teacher, Science, BioScience,* and *Journal of College Science Teaching.* This exercise begins with distributing a selected article to all the students. Copies of letters to the editors in response to that article are given to only *half* of the class. The students have two weeks to read the material and search for additional information related to the topic. At the next meeting, students are paired off for debate. The students who read both the article and the letter to the editor act as the critics. The remainder of the class, who only read the article, act as the authors. The debate usually runs 45 minutes. A general discussion with the entire class follows. In this activity students learn how to constructively criticize scientific and philosophical articles and issues.

Students Ask Their Own Questions

Effective teachers "... have always tried to teach for thinking: to teach academic content in a way that strengthens students' cognitive abilities" (Wood 1987). It is important that students become conscious of their own thinking processes. One of many ways to do this is to ask students for clarification, elaboration, and evidence for their ideas. Some questions which start with the following phrases have shown positive evidence in strengthening students' cognitive abilities: List all the problems, solutions; What are the consequences; How many hypotheses can you suggest; What would happen if; and so on (Bloom 1959).

After we finish studying a given unit, I ask each student to write four questions which must begin with "why?" and answer two of them in the class (the questions are turned in). These four questions must be different from the study questions at the end of each chapter in their textbook.

I also ask students to write four "why" and "how" questions at the mid-term and final exams for extra credit. These questions must be different from the questions in the original exam and the student must answer two of them in an essay format.

Collaborative Study

After every mid-term, I identify the main areas or topics where most students had difficulty. The class is divided into groups of three, with each group including students of different levels of learning; excellent or very good, good or pass, and poor. I provide information sheets to each group, and students work collaboratively to answer the six "how" or "why" questions included. I assist each group as necessary during collaboration. Each group receives one grade based on their performance, how well they interact, and how well they answer the questions. Students must *discuss* their answers *before* they write them down.

The students enjoy collaborative instruction and learn a lot about clarifying and reinforcing their mutual understandings of a given concept. This

method is helpful for shy students who may be reluctant to raise comments or questions in class. Further, group discussion is a key to encouraging students to learn from each other, in addition to the instructor.

A Creative Semester-Long Project (The Final Project)

As a course requirement, every student must undertake a semester-long project to explore a given scientific concept. With the intention of preparing students for life outside of college, this project requires them to integrate their field of interest and their particular strengths to produce a unique piece of work. Students must creatively explore and express their understanding, appreciation, wonder, or criticism of scientific concepts through the media of their choosing. They must work either individually or in pairs; I encourage pairs so that they can share the time required to produce a substantial piece of work.

Unlike the free classroom creative assignment, the semester long project is presented to the class at the end of the semester and evaluated, 50/50, by the instructor and the students. Students who produce worthwhile creative projects are eligible to enter their work in the Yearly Creative Project Competition, sponsored by the Science and Mathematics Department—some project results go on to be published or commercialized. This assignment is a requirement in every course in Columbia's science department.

Table 1. Examples of Interviews Published in *Calypso Log: The Cousteau Society Journal* and Re-Created by Students

Interview Subject	Title of Interview	Interviewer	Date and Source
Group of scientists from different countries	Antarctica Scientists: A Global Community	Calypso Log	16(2):14-15, 1989
Dr. Peter H. Raven	A Voice for Biodiversity	Tim Knipe	16(3):7-8, 22, 1988
Dr. Edith Brown Weiss	Designing a Legal Framework for the Rights of Future Generations	Steven Krolak; R. Schwabacher	19(1):9-11, 1992
Dr. Henry W. Kendall	Public Policy and Technological Man	Paula DiPerna	11(3):2-5, 1984
Dr. Colin Turnbull	Crossing Cultures	Paula DiPerna	11(4):2-5, 1984
Don Widener	The Environment, the Press, and the Public	Pam Stacey	12(3):4-7, 1985
Lowell P. Weicker Jr.	Swimming Upstream in the U.S. Senate	Pam Stacey	12(4):7-10, 1985
Dr. James A. Lee	The World Bank and the Environment	Calypso Log	13(1):5-8, 1986
David Lange	Prime Minister of New Zealand	C. Cousteau	14(2):7-9, 1987
Hilda Diaz-Soltero	Banking on Resources: Debt Swap	Paula DiPerna	14(4):17-19, 1987
Oscar Arias Sanchez	Peace on Earth; President of Costa Rica	J. M. Cousteau	14(4)4-7, 1988
Dr. Garrett Hardin	The Commons in Crisis	Mary Batten	15(2):17-19, 1988
Dr. Stephen Jay Gould	Charting Life's Unpredictable Pathways	Mary Batten	15(4):14-17, 1988
Dr. Rodrigo Carazo Odio	Disarming the Mind	Mose Richards	15(3):8-9, 1988
Julia Henderson	Stabilizing the Human Family	Mary Batten	15(5):14-16, 1988
Dr. Noel J. Brown	Crossing the Boundaries	Tim Knipe	15(6):14-16, 1988
Captain Jacques Cousteau	Educating the Public	Mary Batten	16(1):4-7, 1989

Conclusion

Through instructional strategies such as these we try to give students alternative opportunities to maximize their learning productivity and to help them become more inquisitive, willing to take chances, and become more appreciative of science, art, mathematics, and humanity. We hope this helps them to become more creative people and will contribute to advances in their knowledge and future achievements.

Instructors should use a variety of teaching approaches and provide various learning channels to achieve learning objectives and to generate and maintain interest among students. Students should feel they have a choice in what they learn, how they learn it, and understand their involvement in the depth of exploring complex topics.

Most of the instructional strategies discussed in this paper take some planning and considerable energy. They also require both an institutional and instructional support system. Collaboration between instructors both within and across disciplines is helpful. ❑

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FEATURES

DEPARTMENTS

ALSO IN THIS ISSUE

Cover: A haunting photograph of the Egyptian pyramids near Cairo at dusk. In the feature article, "Physics Education and Gender Roles in Two Arab Countries," (p. 51), George Mason University Professor Robert Ehrlich and co-authors discuss their impressions of the status of women in science in the United Arab Emirates and Egypt following a recent visit to both countries.

Science And Mathematics Department

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Class Final Creative Project Grading Sheet																	
Student Name		Scientific Knowledge				Art Creativity				Evidence of Originality				Integration of Science & Major			
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Student Signature _____

Today's Date _____