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Inviting Nontraditional Students into the Science Culture

Nontraditional students can feel academically at-risk in their first college science courses. It is imperative that science teachers implement innovative approaches, create novel pedagogic techniques, employ extraordinary strategies, and, in general, discover an elixir to affirmatively embrace this population within the science culture.

Some strategies (learned through trial and error) seem to work:

1. ***Breaking the "isolation barrier" and forming a learning community.*** The first class session begins with an informal introduction to the course, the instructor, and all the members of the class. After revealing my age, background, how I entered teaching, my most embarrassing moment (along with other anecdotes), students are invited to introduce themselves, tell why they enrolled in the class, describe the picture that comes to mind when they hear the course title, describe their current occupation, and explain their future goals. Along with these brief biographies, tension-reducing laughter is provoked by asking them to identify their favorite animal, or least-liked food, or preferred color, etc. Those who are continuing students are asked to mentor neophytes to the college. Students are urged to exchange phone numbers and to form cooperative study groups.
2. ***Perception of the world and construction of meaning.*** The second week involves examining perceptions and how we construct the world from sensory information and prior experience. I offer some optical illusions, and the students are directed to draw their own illusions and explain what they sense from these images. Incomplete and ambiguous figures, gestalt representations, after-images, moving illusions, and discrepant events are examined to show how perception is influenced by senses, associations within the brain, preconceptions, expectations, and cultural influences. There are no "right" answers for any of these activities. Students, working in groups, learn that while we each may view the same thing or idea, we may perceive and react to stimuli differently. There is no absolute way to evaluate information, not unless we agree on arbitrary standards to measure and evaluate qualities.
3. ***Students as participants to clarify conception and reception.*** Course objectives are followed in lectures and illustrated by laboratory activities. However, students are encouraged to participate in question and discussion activities during lecture. It is essential that these students verbalize and gain a proficiency with the language that they have difficulty in pronouncing and graphically writing. During the lecture portion, the students are invited to recapitulate, in their own words, how they interpret the content. With the right atmosphere, such activity initiates student interaction in verbalizing the material, and it permits examination of preconceptions, or naive assumptions, which can be examined. [One student courageously, but frustratingly, asked after extensive review of Darwin's work and the generalizations derived from his observations that led to key points in the evolutionary theory, "Well, I understand all that, but what do these words *natural selection* mean?" The words encapsulating the concept did not connect the idea for this student, and so we were able to dissect the meaning of the words and to tie together the concept with the triggering title.]
4. ***Liberating science from classroom confines.*** Many students have never been to a public science facility. As part of the course requirement, students are to visit a science center, museum, laboratory, research center, marine world, arboretum, zoological garden, or aquarium. The choices are almost endless. In addition, they are to write a short report describing the purpose of the center and their impressions. This has been a revelatory experience to many students. Little did they believe that they would enjoy these outreach activities identified with science.
5. ***Newspapers and other media as part of the text.*** News diaries, in which each student collates three science news items weekly for 10 weeks, are required. Each student summarizes in one page the three news articles that made the greatest impression. Scientifically literate students are expected to comprehend and comment on science news stories. Using TV schedules, students select to watch either one-hour or two half-hours of a current science program. Two-

page reports detailing the content and elaborating on the familiar and the unfamiliar, along with any other remarks commenting on the delivery of the material, are encouraged. These efforts are not graded, but the assignments are course requirements and cost a letter grade if the assignment is unfulfilled.

6. ***Outside (non-text) science reading.*** As part of the course readings, short essays or chapter selections from natural science collections are assigned to acquaint students with science writing. James Thurber's "University Days" fits in well with the microscope lab. Isolated chapters from Roeche's medical mystery series, "The Beetle of Aphrodite," Lorenz' "King Soloman's Ring," Quammen's "Natural Acts" column in *Outside* magazine, and Walt Whitman's poems extend science to other worlds.
7. ***Science as part of the community resources.*** To show abstract science in operation, classes have been given tours through local farms, seed research facilities, aquaculture laboratories, a university medical school, zoological gardens, exercise physiology centers, food technology plants, and medical laboratories. In addition, speakers from city services have given class presentations on chemicals in the environment, pollution hazards, and firefighting techniques.
8. ***Students actively involved in their own laboratory set-up and design.*** Students need concrete hands-on experiences to make this esoteric subject real. To show that the materials are not mysterious potions or exotic substances, students are encouraged to weigh out and make up the laboratory solutions and to bring in the examined materials. Common everyday materials found in the home are preferred. For osmosis demonstrations, the students make sauerkraut and bring in naked eggs that have been deshelled in vinegar. Red cabbage solution or beet water made at home are used as indicators for pH changes. Students observe the effervescence created by the enzyme breakdown of hydrogen peroxide when it is mixed with liver, yeast, or blood; but they do not have the faith to accept that this gas is oxygen. Empower them to thrust glowing splints into the foam and watch them ignite.

   These are exercises which they take home and repeat for themselves or perform for their families. Since students know so little about living materials, they must collect their own snail, dig up plants to find root nodules, visit fields to bring back evidence of living things to examine under the dissecting microscopes, search for owl pellets, visit preserves with identified plants and animals. Students have brought in animal blood from veterinarians, insect and plant oddities, medical records, exotic pets, ostrich, emu, and hummingbird eggs, to name a few.
9. ***Seminar approach for interactive discussions.*** A relaxed round-table approach is used usually during the laboratory periods immediately before a holiday to relate findings from the news reports, readings, media programs reviewed, and science centers visited. These report sessions are viewed somewhat apprehensively at first, but they soon become intimate and vociferous family discussions.
10. ***Marketers of science learning.*** The best way to learn is to teach—so students are involved as docents in science open-houses to the community. Participants are invited and provided with materials to demonstrate a science activity to their children's or sibling's grade school classes. These include polymer formation in slime preparation, using household substances to illustrate chemical reactions, and playing with illusions. Non-major chemistry students put on a chemical Christmas show using demonstrations that they have found in library books (I suggest hunting through the children's section).
11. ***No-fault learning: Ungraded writing and reports.*** Students have been conditioned by grades to produce the expected or to behave in an accepted manner. Eliminate grades for reports but comment generously in constructive ways to encourage them to explore different ways of thinking and generating information and ideas. While these ungraded assignments receive no letter reward, such assignments do serve as stimuli to encourage the science-leery and grade-conscious student to dare try other ways of thinking and of exploring different modes of expression. Students need the security of being able to gracefully stumble in order to refine their performance.

Instructors must combine expertise with sensitivity, be flexible in meeting changing needs, have unbounded enthusiasm to infect students, yet hold attainable expectations. We must loosen barriers and invite more initiates into the culture of science. It enriches all of us. As science educators, this is both our mission and our role!

Rita A. Hoots, *Instructor, Biology, Anatomy, Chemistry*

For further information, contact the author at Yuba College, 41605 Gibson Road, Woodland, CA 95695.

Suanne D. Roueche, Editor

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