EDITORIAL

Preparing High School Students for College Science Classes

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What do high school graduates need to know and be able to do to be successful in college science courses? This was the topic of an enthusiastic panel during NABT's 2008 National Conference in Memphis. The panel consisted of university professors and high school biology teachers. Each member of the panel provided his/her point of view on the topic and then questions were solicited from the audience. Several themes emerged as to what college professors look for in freshmen and what high school teachers say about the preparation of their science students.

First, college professors want students who are problem-solvers and are able "to think their way out of a brown paper bag." Merely memorizing information does not adequately prepare students for the rigors of college life where deciphering, interpreting, and reasoning of biological information is critical to success in science courses.

Those high school teachers providing real-life scenarios focusing on biological concepts afford the opportunity for greater understanding in their students. These scenarios allow students the opportunity to apply their knowledge of concepts in a practical, thoughtful manner. For example, when high school students are confronted with a land use problem and are encouraged to use ecological concepts (such as carrying capacity, immigration and emigration, and population growth), they must work with these concepts firsthand rather than learn them passively. During their initial biology course in college, the students recall these scenarios to assist them in deepening their knowledge of the concepts. If students do not actively work with concepts in high school, then the college courses can be a frustrating experience because the concepts learned in high school are one-dimensional.

The use of problem-based learning during high school science courses also facilitates the students' ability to grapple with the concepts addressed during the college science experience. Problem-based learning focuses on a scientific problem, such as the use of DDT worldwide, the advantages and disadvantages of cloning, the decisions made for organ transplantation, and issues surrounding forensics. Problem-based learning supports John Dewey's idea that "true learning is based on discovery guided by mentoring rather than transmission of knowledge." (Boyer, 1998, p. 15). Problem-based learning provides students with the chance to apply their concept knowledge to a relevant issue in science, work cooperatively in teams, enhance communication skills, and think critically in analyzing complex problems.

Second, high school students engaged in inquiry understand the nature of science as well as procure a more in-depth knowledge of key concepts in biology. Sadler and Tai (2001) found that students participating in high school courses examining fewer concepts in more depth as well as working meaningful problems and engaging in labs performed much better than students whose teachers sped through more concepts in a textbook-centered, teacher-driven class. More and more university science courses are converting to being inquiry based and using active learning strategies (Knight & Wood, 2005; Udovic et al., 2002). Students engaged in inquiry experiences are more likely to be drawn to careers in science. As a result, these students complete college science courses in greater numbers than non-inquiry based students (Gibson & Chase, 2002).

Third, high school teachers who assist their students in study skills, knowledge acquisition, and the ability to think divergently provide a more solid base for success in science courses at the college level. Promoting activities that foster creativity, questioning, and wonder facilitate students' interest in science as opposed to students' seeing science as a discipline consisting of unrelated facts stacked in an innocuous manner.

Time management is an issue for many college freshmen. High school teachers can assist students manage their time between academics, extracurricular activities, work, and studying. High school students don't often recognize the need to spend several hours studying for every one hour they spend in a college science course.

Reading for understanding is also critical. Those high school teachers who have their students read actual scientific papers and science articles in magazines such as *Discover*, *Skeptical Inquirer*, and *National Geographic* provide opportunities to engage in the scientific literature. Having students examine and critically evaluate science-based Web sites also aids in developing scientific literacy. Being able to summarize key ideas presented in the readings assists students in developing their own understanding of the concepts. The students need to be active, engaged readers.

Students also need to be able to connect scientific concepts in a meaningful way. Using concept maps during high school facilitates students' understanding of concepts and their relationship to one another. Concept maps also provide a useful skill for working with concepts as a study skill once in college. The more high school teachers can provide ways for students to study content in a meaningful manner, the more ready students will be to handle the challenges of college life.

More rigor in high school translates to more success in college, both in the lectures and the laboratories. Teachers fostering independence among their students provide a strong foundation for the necessary independent study required in college courses. Students need to understand that there is no hand holding in college. The more student-directed the high school courses can be, the better able students can adjust to college life. Rigor implies the necessity of students to be engaged with the material in a manner challenging their current conceptions and pushing them to wrestle with the major ideas in biology. Rigor is not a part of passive learning where students idly accept whatever material is presented without contemplating the meaning of the concepts.

High school science teachers using teacher-directed instruction involving primarily lecture, with a few labs scattered throughout the year, substantiate their methods because "Students need to be able to be good note-takers in college." But, these methods provide a cursory view of the content where students learn for an exam but forget soon after. When notes are taken, the students need to work with the notes, and personalize them with sketches, charts, schematics, and summary statements (Einstein, Morris & Smith, 1985). Merely taking notes down without synthesizing the ideas involves little thought and consideration.

High school teachers play a vital role in the preparation of students for college science courses. Through inquiry, appropriate study skills, rigor, time management, and fostering independence, their students are better apt to succeed in science courses and to approach science careers as a possibility. Teachers must ensure they do not foster blind acceptance of the material but provide opportunities for students to question the concepts, to aptly confront the data, and to embrace the concepts for themselves. Monro (1999) summarizes Bertrand Russell's notion of the unquestioning habits of students to their teachers. The students see the teachers as knowing more than they (themselves) and therefore are reticent to question, analyze, and put forth independent thought towards the material. As Russell reasons, ***This is dangerous because it instills the habit of passive acceptance by the students.*** As a result, the students grow into adults who follow leaders blindly instead of continually analyzing the merits of the leaders' words and actions. By fostering independent thinking and encouraging students to actively work towards understanding the material, teachers foster students who are better able to approach the material rationally. Not only will these skills help our students be successful in college, but will enhance their success in later life as well as provide the pathway for lifelong learning.•

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