Teaching Students How to Learn Chemistry

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One of the major barriers that students face in trying to learn chemistry is their misconception that memorizing facts and formulas is equivalent to learning. However, cognitive psychologists make a distinction between rote learning and meaningful learning. Rote learning is verbatim memorization, and is not necessarily accompanied by any understanding of the terms. Meaningful learning, on the other hand, is learning that is tied to previous knowledge, and it is understood well enough to be manipulated, paraphrased, and applied to novel situations.

One particularly effective way to present the different levels of learning is through a discussion of the hierarchy of learning levels (shown in the figure below).

Strategies for Studying to Learn

Our center for Academic Success has had great success teaching students to use "The Study Cycle with Intense Study Sessions." This is a system developed at LSU to provide students with concrete steps they can take to improve their learning. The Study Cycle is easy to learn and implement, and students see an immediate result when they start to use it. The four-step process is described below:

1. Preview or pre-read information before it is covered in class.

   Previewing chapter material (concentrating on the bold-face print, italicized writing, figures, graphs, diagrams, etc.) prepares the mind to receive and comprehend the material that will be discussed in lecture. When students have some familiarity with the material that will be discussed, the level of comprehension during lecture increases, and students indicate that they become more interested in the class. Step 1 of the Study Cycle need only take 10-15 minutes, and can be done just before class if necessary.

2. Go to class, and actively participate in lecture.

   Although this step should not need to be explicitly stated, the absenteeism in large introductory science classes is often extremely high (approaching 50% after mid-semester). Therefore students must be instructed to attend lecture (unannounced lecture quizzes are a great incentive), and told how to make lecture a learning experience. Active mental engagement with the material makes the lecture time study time!

3. Review and process class notes soon after class.

   When information is first learned it goes into short-term memory. Information that is reviewed within hours if being heard is moved from short-term memory into long-

term memory where it can be used at a later time for problem solving and other tasks. Reviewing and reworking lecture notes shortly after the lecture provides the mechanism for the information to be stored in long-term memory. Spending 10-15 minutes soon after lecture reviewing the notes can substantially improve retention.

4. Use Intense Study Sessions.

Intense Study Sessions are concentrated study sessions of approximately 60 minutes duration. During this short, but focused, study time, a considerable amount of learning can be accomplished. An intense Study Session has four parts:

1. Set goals. (first 2-5 minutes)
2. Work to accomplish goals. (35-38 minutes)
3. Review what was studied. (10 minutes)
4. Take a break. (final 10 minutes)

Three or more Intense Study Sessions should be done each day, if possible, with two during daylight hours and one during the evening. The Intense Study Sessions can be real "procrastination busters" and provide a means for targeted study sessions that are efficient and "doable".

Strategies for Homework Assignments

Another important strategy in chemistry helps students move beyond the "plug and chug" exercises that may have made up the bulk of their high school chemistry experience. Many students are surprised that their successful completion of homework assignments does not translate into good grades on examinations.

When a student does well on homework, but not on a test, the question to ask is: "When you do your homework, do you read the problem, flip back on the pages to find an example similar to the problem, and then do the problem based on the example?" Invariably, these students read the homework problem before reviewing the information related to the problem, look for an example, and then "work" the homework problem using the example as the model. This one behavior is the reason that a large number of students think they have "done the homework problems," when in fact the examples in the book have done the homework problems. A simple strategy that has proven quite effective in extinguishing this habit is the following bit of advice.

When you start the homework, study the information relevant to the problems as if you will be quizzed on it. Treat the example in the text and in the notes as homework problems. Read the problem statement in the example, but do not look at the answer. Work the example problem by using information learned from studying the concepts. After having worked the example this way, solve the homework problems without looking at any examples. In fact, it is quite useful to pretend that you are doing these problems for a test or a quiz.

With an appropriate explanation, students easily understand the difference in the skills being tested during an exam and those developed by using examples to solve the homework problem!

When students use the strategies discussed above and they see improved results a more positive attitude and better performance results. My greatest joy in teaching has been to witness the transformation that occurs when students realize that when they learn *how* to learn, learning chemistry is not hard at all!