Session 1451

Teaching Actinide Environmental Chemistry at Clemson University

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ABSTRACT

A combination of teaching/presentation techniques was used in a new actinide environmental chemistry course to accommodate the various learning styles of the students. The course focused on the environmental, inorganic and process chemistry of the fascinating elements at the bottom of the periodic table. Lectures covered chemical and physical aspects of actinide metals and compounds (such as properties, structure and bonding, reactions, kinetics, thermodynamics), coordination and solution chemistry, behavior and speciation in the environment, separation and purification, chemistry of the nuclear fuel cycle and waste treatment and related topics. The lectures incorporated modern accelerated learning techniques, and class participation and special projects were emphasized to enhance student comprehension and learning of the subject. This paper will summarize these techniques and provide illustrations used in the class.

INTRODUCTION

I believe that the process of learning and thinking is a complex combination of colors, pictures, scenarios, sounds and words. Multisensory ways of learning are effective since one stores auditory, visual and kinesthetic memories in different parts of the brain. Accordingly, I tried to use a combination of teaching techniques in an actinide environmental chemistry course that I developed and taught during the Fall of 2000 at Clemson University.

The course was listed for anyone desiring to learn more about the intriguing environmental management chemistry of the f-elements at the bottom of the periodic table, from history and fundamental concepts to recent applications and developments. It was available to graduate students who have taken mathematics through calculus, modern physics and general chemistry. The goal of the course was to use modern accelerated learning techniques and active student participation to learn the general chemical properties of the actinide elements related to their behavior in the environment, in processing and waste treatment, and in other significant applications.

COURSE CONTENT AND SYLLABUS

The following subjects or activities were covered during the semester:

Class Organization, Syllabus, Policies, and Accelerated Learning
Introduction to F-element Chemistry
Overview of Plutonium and Other Important Actinides
Historical Perspectives
Toxicity and Health Aspects--Student Presentations
General Uses of the Actinides
Metal Preparation, Properties and Reactions
Preparation and Properties of Selected Compounds
Introduction to Solution Chemistry
Examination
Solvent Extraction in the Nuclear Fuel Cycle
Ion Exchange in the Nuclear Fuel Cycle
Other Actinide Separation Methods—Student Presentations
Process Chemistry
Waste Treatment Chemistry
Decontamination Chemistry
Analytical Chemistry
Examination
Environmental Chemistry (three lectures)
Review of Solution Chemistry and Oxidation States
Oxidation State Analysis
Complex Speciation
Speciation Modeling Methods
Speciation Modeling—Student Presentations (two class periods)
Review
Examination

In my lectures, a variety of presentation methods were used to accommodate the various learning styles of the students. For example, I used transparencies with a variety of colors and pictures along with the chalk board, showed several videos, and tried to summarize the presented information with learning maps (*vide infra*). About half way through most of the lectures the class was arranged into 2-3 person teams for 5-10 minute problem solving, followed by a short discussion/presentation period; in addition to its cooperative learning attributes, this format allowed the class to essentially have a half-time break for learning improvement. I also utilized other cooperative learning and teaching formats and methods as discussed in Nilson's *Teaching at Its Best*.[1] During the semester the students gave three formal 10-minute oral presentations and prepared a literature review/proposal on a selected topic in actinide chemistry. During the semester, I was fortunate to have four visiting lecturers speak to the students.

I was also extremely fortunate to have seven outstanding students, two from the Chemistry Department and the remaining students from the Department of Environmental Engineering and Science, in which I fostered excellent lines of communication. They freely gave me requested periodic feedback of what they liked and did not like; the informal midterm evaluation sheets were extremely helpful for my presentation improvement.

The actinide chemistry course was mainly descriptive so a considerable amount of memorization of facts was required. Thus memorization techniques, such as learning maps, were utilized as outlined in *Accelerated Learning for the 21st Century* by Rose and Nicholl.[2] In fact, I thought so much of the book that I purchased copies for all the students with my personal funds. The book emphasizes accelerated learning techniques by recognizing that each of us has an individual preferred way of learning that suits us best and provides a method so that the processing styles of the left and right hemispheres of the brain are fully involved. The creation of learning maps was utilized in a variety of situations: when new information is adsorbed using learning maps, retention is increased. A learning map is essentially a memory picture that summarizes information to be learned using key words and pictures logically connected on a sheet of paper.[1] An example is given below.

SUMMARY

In summary, I like to think of myself as being more of a facilitator of discussion in the classroom than as a lecturer. I also like to follow the advice of the Editors of *Education Week* when they stated, "The teacher as a dispenser of information will become a coach and guide. Drill, practice and rote memorization will be replaced by authentic problem-solving, higher-order thinking, decision-making and cooperative learning."[2] I also tried to use humor in the classroom as much as possible since it has been stated in *Creative Training Techniques* by Bob Pike that "People learn in direct proportion to how much fun they are having."[3] Finally, I tried to emphasize the importance of actinide chemistry and what the students could really use for their future careers and private life. I also tried to emphasize the conceptual understanding of actinide chemistry above rote memorization, but indeed used a variety of memorization techniques when possible. For example, I think you, the reader, could easily remember the names of the actinide elements (named after people and places) by reading the following story and drawing a learning map illustrating the story in a clockwise fashion:

Actinium (Ac), 89, and Thor (Th) (Norse mythical god of thunder and war) were married and had a baby Protactinium (Pa). The three of them boarded the Space Shuttle and went to Uranus (U), Neptune (Np) and Pluto (Pu), and then returned to America (Am) where they met Madame Curie (Cm) at Berkeley (Bk), California (Cf) as well as Einstein (Es), Fermi (Fm) and Mendeleev (Md); there they saw the Nobel (No) (note alphabetical order between Bk and No) that had been awarded to Lawrence (Lr).

REFERENCES

1. Nilson, L.B., *Teaching at Its Best*, Anker Publishing Company, Inc., Bolton, MA, 1998.
2. Rose, C., and Nicholl, M.J., *Accelerated Learning for the 21st Century*, Dell Paperback, New York, 1997.
3. Pike, B., *Creative Training Techniques*, Lakewood Books, Minneapolis, MN, 1990.

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Prior to joining Clemson University as Professor of Environmental Engineering and Science in January 2000, he was an Engineering/Scientific Fellow at the Idaho National Engineering and Environmental Laboratory. He has also worked at other U.S. Department of Energy sites in California and Colorado as well as the International Atomic Energy Agency in Vienna. He has held teaching positions at the University of Colorado, Colorado School of Mines, University of New South Wales (Australia) and the University of Idaho. He received his Ph.D. in Analytical Chemistry from the University of Colorado in 1975.