SCIENCE EDUCATION

Chairman: Patricia A. Zeck
Northwestern High School
Kokomo, Indiana 46901

Chairman-Elect: Stanley S. Shimer
Science Teaching Center
Indiana State University, Terre Haute, Indiana 47809

ABSTRACTS

Indiana Public School Enrollment Trends in High School Science Courses (1968-1981). Jerry M. Colglazier, Science Consultant, Division of Curriculum, Indiana Department of Public Instruction, Indianapolis, Indiana 46204.——Data annually collected and totaled by the Indiana Department of Public Instruction regarding Indiana public school enrollments in high school courses were tabulated and reviewed to identify enrollment trends in science courses. Although the number of students enrolled in high school science courses increased in the early seventies, this increase did not keep up with the increase in the early seventies, this increase did not keep up with the increase in total high school membership, in fact the percent of students enrolled in science, particularly second, third and four year science courses, declined up through the 1973-74 school year. From the 1975-76 school year through the 1979-80 school year, the percentage of students enrolled in science showed a very slight upward trend; however, the percentage enrolled in advanced courses remained nearly constant. During the last two years (1980-81 and 1981-82), the percentage of students enrolling in science has turned perceivably upward. Increased enrollment in biology and chemistry account for most of this increase although a slight increase is detectable in the physics enrollment data. Analysis of class data seem to indicate that beginning with the graduating class of 1983, Indiana public school students began enrolling in science in perceivably larger percentages. It will be interesting to see if: (1) this trend continues and (2) if physics enrollment percentages have increased this school year. In the fall of 1981, 49.8% of Indiana's public high school students were enrolled in a science course compared to a low of 46.8% in the fall of 1973. The equivalent of 74.0% of the 1981 freshmen were enrolled in biology, 24.2% of the 1979 freshmen were taking chemistry and 9.7% of the 1978 freshmen had elected to take physics.

Results of an Inservice Needs Assessment for Improving Science Instruction in Indiana Schools. Jerry M. Colglazier, Science Consultant, Division of Curriculum, Indiana Department of Public Instruction, Indianapolis, Indiana 46204.——A random sample of Indiana public school elementary teachers, of middle school science teachers and of high school science teachers and all science supervisors were sent a questionnaire in April, 1982. In addition to some demographic data, the questionnaire asked respondents to indicate how valuable they considered each of 29 categories of inservice programs and 14 possible other support services. They were also asked to rate possible inservice delivery arrangements. The return rate was about 30.0% for all teacher groups and 88.0% for supervisors. The data was processed using the Statistical Package for the Social Sciences.

Science Requirements for Indiana Schools: Past, Present and Future. JERRY M. COLGLAZIER, Science Consultant, Division of Curriculum, Indiana Department of Public Instruction, Indianapolis, Indiana 46204.——For many years, the rules of the Commission on General Education, Indiana State Board of Education, relating to the science curriculum, in fact the total curriculum, remained constant. These offered only suggested guidelines for the content areas to be included in grades one to eight while requiring one year of laboratory science for high school graduation. The list of science courses acceptable to meet this requirement was altered from time to time between 1937 and 1978; however, these alterations were always somewhat limited in scope. In February, 1978, the Commission promulgated a new set of rules (actually a section of Indiana Administrative Code) which became effective in June, 1978. In terms of curriculum, the main changes from previous rules were that of specifying minimum time allocations for each subject in grades kindergarten through eight. In terms of science, they required that 15.0% of the kindergarten program be devoted to social living and environmental experiences; 5% of the time in grades 1-3 be devoted to science/health/safety education; and 10% of the grades 4-8 be devoted to science. During 1982, the Commission has been considering a revision of the curriculum sections of the Indiana Administrative Code. Proposed revisions would separate science and health/safety education in grades 1-3, allocating 5.0% of the instructional time to each one; increase the 10.0% requirement to 12.0% in the middle school grades; and greatly expand the list of acceptable high school science courses.

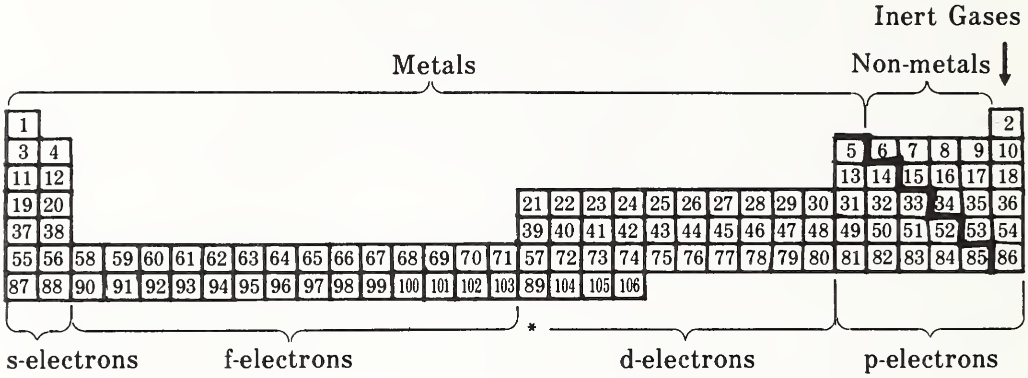
Solving Moles Problems: Strategies and Errors. DOROTHY GABEL, Department of Science and Environmental Education, Indiana University, Bloomington, Indiana 47405.——During the 1979-80 school year 74 high school students in south central Indiana from seven high schools were taped while they solved three chemistry mole problems aloud. Problems became increasingly more difficult beginning with one step problems and culminating in three step transfer problems. Before students began solving the mole problems, their background of prerequisite knowledge necessary for solving the problems was assessed by asking them a series of questions on the concept itself.

Students' responses were coded and classified according to the type of errors made. Tapes were further coded to determine the general problem solving strategies used according to Polya's heuristics. Data were analyzed using nonparametric statistics.

Results of the study indicate that students' major difficulty in solving mole probelms is lack of understanding of the mole concept. Specific errors that were identified could be classified as (1) using the wrong operation but understanding the concept; (2) lack of understanding of the mole itself, e.g. confusing moles with mass, volume and molecules; (3) using the wrong conversion factors and (4) failure to use moles in the problems. Students generally solved problems using only algorithms and only rarely check to determine the reasonableness of their answers.

A Teaching Tool for Introducing Elements: The Expanded Periodic Table. LINDA HAMRICK, The Canterbury School, Fort Wayne, Indiana 46807.——In 16 years of teaching general science, introductory utilization of the Periodic Table of Elements invariably brings the question, "What about the elements that are 'left over' across the bottom?" Although chemists certainly have a firm grasp of the place the f-electron Rare Earth Elements occupy in the overall scheme of things, for students encountering the table initially, the positioning of the Lanthanides and Actinides can be a source of confusion. One answer which the author developed and found helpful over 8 years of use is an Expanded Periodic Table which fits the Rare Earth Elements into a continuous array with the rest.

EXPANDED PERIODIC TABLE



Atomic numbers 51 and 89, (asterisk in the table above), dropping back and adding the first d-electron in the Transition Elements is the only discontinuity, (and a minor one compared to the student-view of an entire group of 14 elements being "forgotten and added on later" which is the typical perception). The f-electrons then fill in neatly, leap over 51 and 89 (already added), and proceed smoothly across the d and p-elements.

Although there is not enough room in the squares for detailed information, the presence of numbers does provide the required identification, while maintaining an introductory simplicity which is highly conducive to understanding in the newer student. Later, when the pupil has a feel for the inherent unity of the elemental relationships, the idea that the size of paper in combination with the amount of information to be squeezed into each square, necessitates "pulling out" the Lanthanides and Actinides, and placing them at the bottom is explained. It is not, of course, proposed that this version replace the current format of the Periodic Table, but rather be utilized as an initial teaching tool for introducing a clear rationale behind its structure.

T.I.P.—An Intensive Science Tutorial. G. C. KYKER, JR. and F. A. GUTHRIE, Rose-Hulman Institute of Technology, Terre Haute, Indiana 47803, and W. A. Deutschman, Oregon Institute of Technology, Klamath Falls, Oregon.——The Iceberg Project (T.I.P.) is a two-week summer program for exceptional students who will be high school seniors in the upcoming academic year. It has been operated by Rose-Hulman for the past three summers. A research-oriented program rather than a "course" as such, its goal is to provide the student with an experience of scientific investigation as it actually takes place. The special characteristic of this program is the intensive collaboration of a faculty member with a small group of no more than six students. Students spend well over half the time in their small group, and can deal with their particular research poblem in considerable depth. Representative topics have included neutron activation analysis, holography, organic synthesis, and games theory. Other features of the program include an introduction to digital computer use, both for scientific programming and word processing; production, entirely by the students, of a collaborative research report; and evening programs on scientific topics of general interest. These and other aspects of the program will be discussed, and our fist three years' experience with it evaluated.

Chemistry Laboratory Experiments Encouraging Abstract Reasoning: Their Use in the High School. JOHN A. RICKETTS, Department of Chemistry, DePauw University, Greencastle, Indiana 46135 and LUCY BROOKS, Western Boone Junior-Senior High School, Crawfordsville, Indiana 47933.——A set of chemistry laboratory experiments will be described. Their experimental design is based upon the Piagetian model for cognitive development; each experiment is constructed as a Learning Cycle, as described by Robert Karplus (SCIS, Teachers' Handbook (1974), Lawrence Hall of Science, Berkeley, California). A salient feature of the Learning Cycle is its devision into three distinct parts, Exploration, Invention, and Application. In these laboratory experiments the three parts are separate experimentally; however, they are connected logically. The observations and conclusions from Exploration are necessary to understand Invention; the conclusions reached in Exploration and Invention are necessary to formulating and understanding the Application.

Abstract and analytical reasoning skills are essential to the understanding and mastery of all academic disciplines. Little or no attention is given to the student within his/her high school experience to strengthen reasoning abilities; consequently, the initial college experience can be an academic disaster—especially in those disciplines that use the hypothetico-deductive method coupled with quantitative reasoning. With the Learning Cycle the science laboratory can be constructed to introduce the techniques of the science and simultaneously develop reasoning abilities. Four specific chemistry Learning Cycles, (1) The Chemical Dilemma, (2) Indictive Reasoning from Chemical Experiment, (3) The Plot Thickens, and (4) The Great Titration Mystery, were tested within a high school chemistry class of twelve students at Western Boone Junior-Senior High School.

The reasoning abilities of the students were assessed before and after performing the laboratory using puzzles requiring proportional, probabalistic, and combinatorial reasoning abilities. Within the group of twelve students, seven exhibited marked improvement in their reasoning abilities. Two who were initially categorized as concrete operational remained concrete operational; the three who were initially classified as formal operational remained formal operational.

Teaching to Overcome Personal Preference of Topics in Zoology. PATRICIA A. ZECK, Northwestern High School, Kokomo, Indiana 46901.——To determine if teacher predilection of topics in zoology had any effect on student preference of the same topics, the students and teacher independently ranked eight topics according to preference. Seventy-six high school students in the course chose seminar, genetics, and vertebrate anatomy and physiology as their favorites. The teacher picked ecology, genetics, and seminar. Their next cluster of choices was embryology and invertebrate anatomy and physiology. Their last group was ecology, evolution, and science projects. Seminars (*Proc Ind Acad* 86:416) were first because of their unique diversity. Science projects were last because of the amount of work required. Students ranked anatomy, physiology, and embryology higher than the teacher. Consequently, it is possible to convey successfully enthusiasm for a topic that is not necessarily the teacher's favorite.

The following teaching methods were used to achieve this success:

1. Approach every topic with a positive attitude.
2. Be "over prepared" especially on difficult material.
3. Use a variety of media such as handouts to match overhead transparencies, movies, written outlines of each lecture-discussion, vocabulary lists, specific quantities of lab work per session.

4. Stress applications of each topic to careers and college education.

5. Remember that teacher enthusiasm and patience stimulate students' learning and enjoyment.