

SCIENCE EDUCATION

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ABSTRACTS

Earth Science for Elementary Teachers. **MARSHALL D. MALCOLM**, Department of Education, Purdue University, Lafayette, Indiana 47907. —In the summer of 1972 a methods course in earth science was held for elementary teachers and for graduates who had completed their student teaching. The students did activities and made constructs from the following subject areas; rocks and minerals, astronomy, mapping, meteorology, oceanography and fossil collecting. On two occasions elementary school students were invited to the lab so that some of the constructs could be pre-tested prior to usage in the classroom. Slides were shown of the students pre-testing their constructs.

An Evaluation of the ISCS Program. **F. LEON BERNHARDT**, Biology Department, Ball State University, Muncie, Indiana 47306, and **RICHARD L. WRIGHT**, Route 4, Sturgis, Michigan. —The science achievement and interest of students taught the ISCS program were compared to the science achievement and interest of students taught science by traditional methods. The correlation of the contributory learning factors of sex, time of day class met, reading, and math with interest and achievement was also examined. None of these factors were found to be statistically significant with achievement as measured by the ISCS test; but most correlated with achievement as measured by the Iowa and Stanford Tests. The ISCS program does not appear to discriminate against students who rank low in reading and mathematics achievement.

An Integrated Science Program for Preservice Elementary School Teachers. **A. DE VITO**, Department of Elementary Science Education, Purdue University, Lafayette, Indiana 47907. —As part of a 3-year sequential science preparation program for pre-service elementary teachers, Purdue University was awarded a 2-year National Science Foundation UPSTEP grant. This is a joint award to the Department of Biology and the Department of Education. The project will combine the expertise of the faculties of the School of Science and the Department of Education at Purdue University in the development of a program for the improvement of the pre-service science education of prospective elementary school teachers. The program will emphasize "Man and His Environment" as the major theme.

The project is a pilot study involving 60 pre-service prospective elementary teachers (freshmen). The participants will be involved in

the new national curriculum projects such as Science—A Process Approach, Science Curriculum Improvement Study, and Elementary Science Study. This will be followed by an integrated science sequence integrating chemistry, physics, biology, and earth science. Concurrent with this instruction emphasis will be placed on early direct and continued experiences with children and individualization of instruction.

Areas of concern such as outdoor education, drug, and sex education will be included in the final semester. These topics as well as prior topics will be structured about the theme "Man and His Environment" and the problem of survival in the face of change.

At the conclusion of the 3-year developmental period a model program for the preparation of elementary science teachers will be formulated for Purdue University and serve as a model for other teacher training institutions.

Cognitive Development and Success in Science. DANIEL W. BALL, Department of Biology, Ball State University, Muncie, Indiana 47306.—This study explored the relationships between formal thinking (abstract) abilities of students, as explicated by Jean Piaget, and their success in science. It appeared from this study that success in science is closely related to the ability of students to perform formal operational tasks. Students who are able to perform these tasks receive significantly higher grades in science than those students not able to perform the same tasks.

The implications of these findings, in terms of science teacher preparation, sequencing science subject matter, and teaching methodology were discussed.

Charts, Globes and Planetarium—Descriptive Astronomy Instruction. NEWTON G. SPRAGUE, Department of Physics, Ball State University, Muncie, Indiana 47306.—A constellation and major star identification semi-programmed learning situation can be based on home study of Mercator Projection Charts with and without titles; establishment of the relation of the Mercator projection to the planetarium celestial equator and coordinate system (10 minutes); a 30-minute laboratory experience of locating the Right Ascension and Declination of 20 bright stars on a 14-inch Farquhar transparent globe; four 50-minute seasonal planetarium presentations scattered during a 11-week period; a quick review (8 minutes) of the total annual sky pattern just prior to the examination; and a 24-item multiple choice Punch-a-Hole-in-the-Correct-Square planetarium test and an overhead projector test of identification of the numbered areas.

Preparation and Evaluation of Programmed Instruction Materials on Acid-Base Theory. TILLMAN E. SMITH, Alexandria-Monroe High School, Alexandria, Indiana 46001, and FREDERICK K. AULT, Department of Chemistry, Ball State University, Muncie, Indiana 47306.—The purpose of this project was to generate and evaluate a programmed unit on the acid-base theories proposed by Arrhenius, Bronsted-Lowry,

and Lewis. Concepts presented in the unit were: nomenclature for acids, bases, and salts; concentration units—molarity and normality; acid-base dissociation constants; hydrolysis; pH; and titrimetry. The unit included laboratory exercises along with problem solving frames related to the above concepts. The rule-example approach was used to develop the unit.

The following evaluation criteria were used: achievement gain; individual attitude toward science; sex of the individual; cognitive style; Preliminary Senior Aptitude Test scores, verbal and math; and Intelligence Quotient. A pre-test and post-test were administered for each criterion. Null hypotheses were generated for each factor and a 0.05 confidence level was used to test for significance. Several single factor analyses of variance and correlation analyses were used to analyze the data.

The population consisted of 42 students enrolled in first-year chemistry at Alexandria-Monroe High School.

A highly significant achievement gain ($p < .001$) was found, but no significant differences attributable to Intelligence Quotient, sex of the individual, Preliminary Senior Aptitude Test verbal, and educational set were found. Significant correlations were found between: attitude and achievement, and Preliminary Senior Aptitude Test—math and achievement.

University-Public School Cooperative Science Enrichment Program: A Project Report. JANE FREES, JOYCE BOYLE, STANLEY SHIMER, and CHARLOTTE BOENER, Science Teaching Center, Indiana State University, Terre Haute, Indiana 47809.—For two consecutive summers, a science enrichment program has been provided to the elementary school children in Terre Haute. This program is a cooperative effort between the Science Teaching Center at Indiana State University and the Vigo County School Corporation.

The two primary purposes of the project were: 1) the improvement of science teaching skills of future elementary school teachers; and 2) the supplementation of the science curriculum for the Vigo County children with instruction which stresses scientific processes and learning by doing.

The pre-service teachers who participated in the program were enrolled in an elementary school science methods course. They prepared and presented 2 hours of instruction 3 days a week for 4 weeks. In addition, they accompanied the children on one or more science field trips. A 1:1 student-teacher ratio was maintained during most of the classroom instruction.

Each university student worked with a peer group team under close supervision of a university staff member as they planned and taught the science lessons. Moreover, the Vigo County School Corporation employed certified instructional personnel to work with the project.

An evaluation of the program was made at the end of both summers. Questionnaires, specifically designed for each group of

respondents, solicited information from the children, their parents and the Vigo County school personnel. The children and parent groups were highly enthusiastic and urged continuation of the program. The Vigo County people reacted positively towards the program; in addition, they offered several valuable, concrete suggestions for modifications in the plan.

The program seems to be a useful part of an elementary school science methods course. As a result, a pilot project is currently being conducted which will place science methods students in elementary school classrooms during the academic year.

Cassette Tapes as Tutors in Freshman Chemistry. FREDERICK K. AULT and SANDRA RATCLIFF, Department of Chemistry, Ball State University, Muncie, Indiana 47306.—General chemistry courses usually are taught to large groups containing more than 100 students and frequently more than 500 students. Since many students enter the courses with little experience in quantitative aspects of science, a large number of students experience difficulty with mathematical concepts and are unable to obtain the necessary assistance to resolve their problems. Large group classes have inherent physical limitations both for students and faculty.

This project was a part of a larger project designed to develop and evaluate individualized materials for the problem-solving areas in introductory chemistry, at the college or secondary level.

The conceptual areas that involve mathematical operations for understanding general chemistry were analyzed. In total, 40 concepts involve the use of algebra. Thirty-six audio cassette tapes averaging 10 minutes in length were prepared. A performance objective for each concept was written and the audio tape instruction prepared to accomplish that objective. The taped instruction was supplementary and specific to the concepts involved. The tapes will be evaluated quantitatively during winter quarter 1972-73 with a large section of general chemistry students. However, qualitative observations were made with very positive responses.

There are numerous pedagogical advantages inherent in this approach to individualizing instruction. The software and hardware provide portability, flexibility, more time for student-teacher interaction, and can be used in any classroom setting. For maximum instructional efficiency, the tapes are recommended for use with single concept programmed instruction units and appropriate textbooks for introductory chemistry.

Are Indiana State University Freshmen Students Operating at a Formal Level in Thought Processes? LARRY BRUCE, Science Teaching Center, Indiana State University, Terre Haute, Indiana 47809.—This pilot study was conducted by a team of graduate students and directed by the author. The problem was to determine the stage of intellectual development of a random sample of freshmen students. The

model for intellectual development used was that proposed by Jean Piaget. Piagetian tasks were formulated on the basis of his reports. Scores derived from the tasks were used to determine the level of development. The scores were also correlated with actual and predicted grade point averages, SAT scores, and high school rank of the subjects.

The tasks required problem solving in situations using a pendulum, an inclined plane, angles of incidence and reflection, volume, and probability. Administration of the tasks was practiced with volunteers until reliable techniques were developed. Each practice session and actual tests were video taped, and observer reliability was established.

Our results indicated that none of the 11 subjects were operating at the formal level. Seven were in a transition stage between formal and concrete operations and four were operating at a concrete stage. Using the Spearman Rank Order Correlation Coefficient the correlation was computed between the Piaget score and SAT, current and predicted grade point average. No significant correlations were found.

Cause and effect can not be established. The majority of the courses offered at the high school and college level are lecture courses. If freshmen students do think at a concrete operational level they are probably memorizing the material and never really develop a functional understanding. Courses probably are not being taught in a manner that is consistent with the students' intellectual level.

NOTE

The Development, Instruction and Assessment of Affective Domain Objectives in Elementary Science Education. H. MARVIN BRATT II, Department of Education, Purdue University, Lafayette, Indiana 47907. —As improved techniques for the measurement of attitudes are found and utilized, more emphasis may be placed on techniques for developing affective domain objectives. Methods for development and validation of instruments as well as a model for effecting change in attitudes towards teaching elementary school science were reported.

A 60-item attitude inventory was developed containing 12 scales, similar to that of Moore and Sutman (3). Each scale contained six positive subscales and six negative subscales. The subscales could easily be written as objectives in the affective domain. Five items were written to assess each subscale. Reliability was assessed by the Winer (4) test-retest method and validity was established by factor analysis.

The model for development of attitudes towards the teaching of science in the elementary school was similar to the mastery model of learning described by Carroll (1). A pre-test determined the attitudes of prospective teachers before instruction. Profiles of the subject's attitudes were constructed and discussed. Specific activities were developed to strengthen approach tendencies (2) to the six positive scales and decrease the approach tendencies towards the six negative scales. A post-test was administered following instruction. Profiles were again constructed and compared with pre-test profiles. Changes in attitude were determined as a result of the comparison.

Literature Cited

1. CARROLL, JOHN. 1963. A model of school learning. *Teachers Coll. Rec.* 64:723-733.
2. MAGER, ROBERT F. 1968. Developing attitude toward learning. Fearon Publ., Palo Alto, Cal. 175 p.
3. MOORE, RICHARD W., and FRANK X. SUTMAN. 1970. The development, field test, and validation of an inventory of scientific attitudes. *J. Res. in Sci. Teach.* 7:85-90.
4. WINER, B. J. 1962. *Statistical principles in experimental design.* McGraw-Hill Book Co., New York, N. Y. 132 p.

OTHER PAPER READ

Design of a Self-instructional Unit Concerning Environmental Biology for the ERAT Systems Approach at Ball State University.
RICHARD W. OLSEN and TERRENCE G. LUKAS, Department of Biology, Ball State University, Muncie, Indiana 47306.