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ABSTRACT

Included in this publication are abstracts of papers presented at a meeting on science teaching. Also included are: an index of authors and the sessions in which they presented papers, a strand index listing sessions that pertain to that strand, and an address list of all the authors. Strands include alternative assessment; approaches to research; curriculum; gender equity; history, philosophy, and epistemology; international; use of technology; science teaching and learning; and teacher education. Science teaching and learning subcomponents include agricultural sciences, biology, chemistry, Earth science, elementary school, environmental; general, interdisciplinary, nursing sciences, physical science, physics, and special education. Teacher education subcomponents include inservice, inservice and preservice, and preservice categories for elementary school, general, high school, middle school, and university/college levels. (LZ)

NARST

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

ABSTRACTS OF PRESENTED PAPERS

EDITORS

Dina Izak
Siu Yoon Chia

Indiana University

67th NARST Annual Meeting
Anaheim, CA
March 26-29, 1994

Abstacts of Presented Papers

67th Annual NARST Meeting
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Overview

The abstracts of the present papers are listed throughout this book by session number. The code at the beginning, S2.04, indicates the day, session, and room.

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A=Saturday, S=Sunday, M=Monday, T=Tuesday

Room Codes

01=Valencia Room
02=Granada Room
03=Madrid Room
04=Barcelona Room
05=Seville Room
06=Plaza Terrace I-II
07=Plaza Terrace III-IV
08=Plaza Terrace V-VI
09=Ballroom V
10=Ballroom VI
11=Ballroom III
12=Ballroom IV
13=Ballroom I-II
14=Commodore Board Room
15=Royal Ballroom
16=Ballroom Foyer
17=Medallion I

You will also find there are several aids to finding abstracts: a table of contents listing the names of the papers, the authors, and the page numbers on which the abstract can be found; an index of authors and the sessions in which they present papers; a strand index listing sessions that pertain to that strand; and an address list of all the authors.

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** *No abstract available.*

** *No abstract available.*

** *No abstract available.*

Poster Session: Curriculum, History/Phil/Epistemology, Science Teaching/Learning, Teacher Education, Use of Technology

** *No abstract available.*

** *No abstract available.*

Contributed Papers: Gender/Equity

Contributed Papers: Use of Technology

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Contributed Papers: Approaches to Research

Contributed Paper: Science Teaching/Learning

Symposium: History/Phil/Epistemology

Symposium: Approaches to Research

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*** *No abstract available.*

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Special Session

Symposium: Teacher Education

Symposium: Teacher Education

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Symposium: Teacher Education

Paper Set: Teacher Education

Special Session

Contributed Papers: Teacher Education

** *No abstract available.*

Special Session: International

Contributed Papers: International

** *No abstract available.*

PRESESSION WORKSHOP

A2.01

PRESESSION WORKSHOP: USE OF MICROCOMPUTERS RESEARCH: ADVANCED ANALYSIS AND DIALOG OF RESULTS (SESSION ONE)
Carl Berger, Joseph Krajcik, University of Michigan, David Jackson, University of Georgia, Katheleen Fisher, California State University at San Diego

The purpose of these two sessions is to introduce intermediate to advanced level microcomputer users to sophisticated techniques of science education research. Participants will use microcomputers to explore techniques at both sessions. The first session will emphasize data gathering techniques using the Event Recorder™, situated interview techniques and ProCite©. Initial analysis techniques will be explored by the participants using SemNet©. Knot-Mac & PC©, and SCCA (sequence comparison or cluster analysis).

PRESESSION WORKSHOP

A3.02

PRESESSION WORKSHOP: PI'EPARING GENDER SENSITIVE SCIENCE TEACHERS
Dale Baker, Arizona State University, Kate Scanterbury, University of Maine

The purpose of this workshop is to provide science educators interested in conducting research in curriculum evaluation with three conceptual frameworks that will help them judge the adequacy of curriculum in relation to gender issues. Project 2061, Science for All Americans, will be used as the curriculum chose for evaluation. The first framework is the McIntosh model (1984) based upon the assumption that the integration of information about women into the curriculum is a process that occurs in stages. The second analytical approach is embedded in a social psychological framework often described as Women's Way of Knowing based upon the five different perspectives described by Belenkey, Clinchy, Goldberger and Tarule (1987): silence, received knowledge, subjective knowledge, procedure knowledge and constructed knowledge. The final analytical framework presented is proposed by the American Association of University Women (1992) in their Issue Brief Creating a Gender Fair Multi-Cultural Curriculum which includes whether topics and materials reflect female and minority interests and concerns. Each analytical model will be applied to Project 2061; then, the three analyses results will be compared, and the participants will discuss how the three approaches can be used for curriculum evaluation with a specific goal of recommendations for curriculum change.

PRESESSION WORKSHOP, AFTERNOON

A3.01

PRESESSION WORKSHOP: USE OF MICROCOMPUTERS RESEARCH: ADVANCED ANALYSIS AND DIALOG OF RESULTS (SESSION TWO)
Carl Berger, Joseph Krajcik. University of Michigan, David Jackson, University of Georgia, Katheleen Fisher, California State University at San Diego

The purpose of these two sessions is to introduce intermediate to advanced level microcomputer users to sophisticated techniques of science education research. Participants will use microcomputers to e. ore techniques at both sessions. The second session wi emphasis further analysis using HyperResearch for qualitative analysis; StatView® and Systat® for quantitative analysis. Display techniques will be demonstrated using PowerPoint® and QuickTime™. Particlpants will receive handouts and demonstration or working copies of several of the applications. Enrollment is limited to 30 persons and each person is asked to bring 3 high density disks for copying demonstration or shareware programs.

GENERAL SESSION

A5.15

SCIENCE EDUCATION REFORM: WHAT IS THE ROLE OF RESEARCH?
Marcia Linn, University of California-Berkeley

What problems in everyday life require science knowledge? Bring your favorite example to add to these:

What should I wrap a drink in to keep it cold?
Why do I need a bicycle reflector in addition to a light when riding at night?
How can I keep warm if stranded on a snowy day?
How can I save energy on lighting a room?
What makes a good stereo speaker?

If students need to solve these problems, what science should we teach?

Research on how natural scientists, engineers, and students solve complex and ambiguous problems like these reveal some surprising implications for science teaching. This and related research can help us reform science to meet the needs of all citizens, including future scientists.

A7.15

DEVELOPING A THEORETICAL BASIS FOR INTRODUCING GEOGRAPHIC INFORMATION SYSTEMS INTO HIGH SCHOOLS

Richard H. Audet, and Gerald L. Abegg, Boston University

During the 1980's, revolutionary Geographic Information Systems (GIS) appeared that integrate an environmental database with an automated map maker. Applications of GIS under development, promise to eventually impact America's classrooms. Because technophiles focus on hardware and software issues, expansion of educational technologies may outpace the associated knowledge base concerning learning and instruction. The emerging consensus is that systematic investigations of how these innovations can support learning should precede the adoption of new educational practices. This study investigated expert based problem solving behaviors with a GIS program called ArcView. The self-reflective GIS problem solving strategies expressed during 'think aloud' sessions were evaluated by naturalistic research methods and analyzed for the presence of thematic components. Three ArcView problem solving styles were identified. Experts used logical formulations to query the database. In the novice population, trial and error methods and mid-level cognitive strategies that relied on spatial analyses were commonplace.

A7.15

THE EFFECTS OF INTEGRATING REAL-TIME WEATHER DATA INTO LABORATORY CENTERED SCIENCE: YEAR TWO OF PROJECT EARTHSTORM

Melanie A. Reap, Ann M.L. Cavallo,
Georgianna Saunders, Brian L. Gerber.
The University of Oklahoma

This study was conducted in the second year of a three year NSF sponsored project (EARTHSTORM) that emphasized the use of a remote sensing computerized system for teaching weather related topics in middle school science. The purpose of this research was to explore relationships between EARTHSTORM teachers and their students in three major areas: cognitive, affective and technical computer skills. The teachers involved in the EARTHSTORM summer institute (N=16 year one; N=17 year two) were pre and post-tested on their understanding of weather, computer skills and attitudes toward meteorology and science. During the academic year following the institute, students were given the same pre and post-evaluations as their teachers. This study provided information on the influence of the EARTHSTORM institute on improving teachers' and students'computer skills and weather-related attitudes and understandings. This study also identified relationships between teachers' and students' understanding of weather, computer skills and attitudes toward meteorology and science.

A7.15

THE BIOLOGY SLEUTH: EVALUATION OF AN INTERACTIVE LEARNING ENVIRONMENT.

Rebecca Denning and Philip J. Smith, Ohio State University

Two formative evaluations of an interactive learning environment were performed. This environment provides support so secondary students may develop related skills in both health concepts and medical problem-solving. In the first evaluation students were videotaped while performing problem-solving exercises which are included in the software. In the second evaluation the students were also videotaped while interacting with the system. Not only were students observed forming and testing hypotheses, they also demonstrated a variety of peer teaching episodes and various group dynamics which are likely to promote learning. The two evaluations revealed differences in the way the two populations worked through the problem-solving exercises. These differences suggest that disparate aspects of this learning environment are beneficial to students of diverse backgrounds. Given this, designers might consider using various teaching mechanisms in future systems so that a wider range of students will be supported while performing problem-solving and learning tasks.

A7.15

EQUITY SENSITIVITY OF PARENTS OF ELEMENTARY SCHOOL CHILDREN

Peggy Daisey and M. Gail Shroyer, Kansas State University

Females and minorities are underrepresented in science- and mathematics-related careers. Parental influence and expectations play an important role in promoting or discouraging their child's participation and achievement in these subjects. Parents completed an open-ended questionnaire (N = 157) or attended one of 21, 90-minute focus groups (N = 94). Parents were presented with a 1956 photograph of two white male scientists in lab coats looking at a test tube. Questionnaire parents were asked "What do you think of this photo?". The moderator of the focus groups explained the stereotype to parents and asked "What is it going to take for girls and minorities to succeed in science and mathematics?" A gender stereotype was mentioned by 31% (48/157) questionnaire parents and a lack of minorities pictured was cited by 10% (15/157). Four categories of responses emerged during focus group discussions: the need for role models (100%, 21/21); the need for better educated teachers in science, mathematics and equity (71%, 15/21); the need for engaging instruction (52%, 11/21); and comments denying the existence of barriers (29%, 6/21). The results suggest the need for intervention programs to make parents aware of the barriers and suggest methods to assist girls and minorities.

A7.15

PARTICIPATORY INFLUENCES ON SCIENCE & MATHEMATICS TEACHING & LEARNING: GENDER, CULTURE & PSYCHOSOCIAL

Pamela Fraser-Abder
New York University

The purpose of this study is to investigate the participatory influences on science/math teaching and learning in an urban setting with specific emphasis on gender, culture & psychosocial variables. A sample of 2314 students from schools in an urban setting was designed to determine what variables influenced their participation in math and science. The survey was designed to determine whether research findings reported in journals were comparable to the situations which currently existed in their urban at-risk classrooms. Results indicated that minority and female students' attitude and achievement in science and math is significantly influenced by their home, school, and community environments.

A7.15

ASSESSING PHYSICS STUDENTS' EPISTEMOLOGICAL COMMITMENTS THROUGH ANALYSIS OF ARGUMENTS

Gregory J. Kelly, Cornell University

This paper reports on student learning in an introductory college-level physics course emphasizing microcomputer-based laboratory (MBL) experiments. The purpose of this study is two-fold. First, student epistemologies are assessed through the analysis of their arguments. Second, the interaction of student epistemological commitments with conceptual development is evaluated. This latter portion of the study seeks to further understand the role a student's conceptual ecology plays in differentially influencing conceptual change. This report focuses on one portion of a larger study relating aspects of students' conceptual ecology, such as epistemological commitments and philosophical interpretation of science, to misconception tenacity and conceptual development.

A7.15

TEACHING SCIENCE AS RELEVANT IS AN IRRELEVANT ENDEAVOR

Alejandro J. Gallard, Florida State University

This is an interpretive study about making science teaching and learning relevant and what this idea means to an eight grade physical science teacher. The setting is Jones middle school in Florida's northern panhandle. The idea of relevance has been stated as an important goal in teaching science. Making science teaching and learning relevant is referred to in many ways: making science more meaningful, making science more identifiable, making science more practical and making science more applicable to everyday life. The notion of learning and teaching science in a way that it becomes more relevant to the student seems to center around what makes sense to the teacher, the curriculum, and educational policy expectations, and not necessarily the student. The notion of relevancy is an important issue to consider given the diversity of today's students.

A7.15

VIEW FROM THE LAB: FACTORS WHICH AFFECT SCIENTISTS' PARTICIPATION IN APPRENTICESHIP PROGRAMS

Clare Von Secker, National Institute of Mental Health

The purpose of this study was to identify factors which motivate scientists to accept or decline participation in apprenticeship programs. The author interviewed 55 tenured intramural research scientists in 24 laboratories at the National Institute of Mental Health. Despite subject differences, there was tremendous internal consistency in scientists' identification of factors which influenced them to accept or decline participation in apprenticeship programs. Positive influences included personal sense of scientific citizenship, sufficient apprenticeship duration, and prior experience. Negative influences included lack of recognition, lack of administrative support, time constraints, space limitations, safety restrictions, and negative prior experiences. The implications for planning apprenticeships are discussed.

A7.15

LEARNING IN THE UNTRACKED MIDDLE SCHOOL SCIENCE CLASSROOM.
Julie A. Bianchini and Nicole C. Holthuis, Stanford University

Untracking at the middle school level raises issues of access, equity and excellence in the science classroom. Two programs at Stanford University -- Complex Instruction and the Human Biology Middle Grades Life Science Curriculum Project -- have collaborated to address these challenges. The first of these two projects provides teachers with a cooperative learning strategy and the second, a curriculum designed for use with this model. The purpose of our study was to measure student achievement in heterogeneous classrooms where Human Biology and Complex Instruction were implemented. Approximately 400 students at three middle schools participated in our study. We administered both pre and post tests for three units: Systems, Digestion/Nutrition, and Circulation. Tests include both objective and open-ended questions; they probe students' understanding of relevant science concepts, processes and applications. Tests were scored using a holistic rubric designed by the researchers. Statistical analysis of student scores showed significant gains in both factual and higher-order thinking. We will discuss the implications of these gain scores as well as the effects of gender and reading ability on achievement.

A7.15

UPON THIS ROCK: A BASELINE FOR WORK IN PROGRESS AT SELECTED PROFESSIONAL DEVELOPMENT SCHOOLS
Lynda R. Flage, Eric J. Pyle, Thomas J. Cooney, The University of Georgia; Susan Ross, Berry College.

This paper examines the prevailing conditions at 5 Professional Development Schools (PDSs) associated with the Georgia Initiative in Mathematics and Science (funded by the NSF Statewide Systemic Initiative Program). A baseline for GIMS activities at the PDSs was established by first surveying mathematics and science teachers and administrators. Further surveys were collected from students and parents at two of the PDSs. The PDS-T (teacher) and PDS-A (administrator) questioned respondents about their classroom activities and practices, beliefs about school efforts towards historically underrepresented groups, and the nature and extent of staff development participation. The PDS-S (student) survey was geared toward student observations of teacher behaviors, while the PDS-P (parent) survey focused on parental expectations of instructional behaviors and student performance. Results show discrepancies between teacher responses and administrator and student observations. The teachers were in general less enthusiastic about school and classroom activities. These results, coupled with an apparent lag between parental expectations and school activities, are salient points that are foci of further investigations. In addition, shifts in PDS constituent group responses against this body of baseline data should aid in the evaluation of GIMS.

A7.15

HIGH-ABILITY COLLEGE STUDENTS' RECOLLECTIONS OF JUNIOR AND SENIOR HIGH SCHOOL SCIENCE.
John Eichinger, California State University, Los Angeles

The impressions of high-ability college science students regarding junior high and high school science education were collected and compared with those of high-ability, non-science college students, using a survey instrument designed by the author. Secondary-level science was held in higher regard by science students than by non-science students, with both groups reporting more positive attitudes toward high school than junior high science. The science students were especially motivated by knowledgeable, enthusiastic, communicative, and committed teachers, while the non-science group preferred patient, knowledgeable, congenial, and supportive teachers. Science interest levels rose significantly for science students in grades nine through college, but remained stable at a neutral-to-interested level in those grades for non-science students. Both groups agreed that although traditional methods (texts, lectures, quizzes/tests) dominated their science experiences, they preferred laboratory activities, teacher demonstrations, and discussions. Overall, secondary-level science teachers, especially at the junior high level, may enhance student interest by implementing meaningful curricula, using active instructional methods, exercising patience with all students, and cultivating an enthusiastic and supportive rapport with students.

A7.15

LITERACY SKILLS AND SCIENCE KNOWLEDGE ACROSS CULTURALLY AND LINGUISTICALLY DIVERSE STUDENTS.
Sandra H. Fradd and Okhee Lee, University of Miami

The study examined the interplay between literacy skills and science knowledge by four ethnolinguistic groups of upper elementary grade students: (a) monolingual English speakers, (b) bilingual English-Spanish speakers, (c) bilingual English-Haitian Creole speakers, and (d) monolingual speakers of black vernacular English. In each group, boys and girls and students from various socio-economic levels were equally represented. The study focused on commonalities as well as differences across these diverse groups of students. The study was conducted in two elementary schools which significantly differed in language, culture, and socio-economic levels. Using three problem-solving science tasks, 16 dyads of students were interviewed by teacher-researchers of the same gender, language, and cultural backgrounds. Differences in languages and cultures occurred clearly in interactional styles, as well as in oral and written forms of communication. While there were no major language and gender differences in science knowledge, social class and community strongly affected science learning and performance. Implications of the findings for science teaching and learning are discussed.

A7.15

Cross-sections to Curricular Constructions: Science Across the Board.
Gary Habib, Florida State University

The purpose of this study was to conduct an evaluation of the development and implementation of an integrated approach to the teaching and learning of science with middle school students. The study has provided insight to alternative approaches to science instruction with the inclusion of computer usage, role play, and analysis of journal writing and videotapes by student participants. During the process, students exemplified multiple evidences of learning. The study has promoted reflective thought, conversations and action for the classroom teacher additional faculty members and school administrators while serving as a integral component for a greater emphasis on the elements of collaboration, collegiality, and school cohesiveness.

A7.15

STRUCTURE MAPPING FOR LEARNING FROM SCIENCE TEXTS WITH ANALOGIES
Marie K. Iding and Thomas Speitel, University of Hawaii

The purpose of this paper is to review factors which can make textual analogies effective teaching devices and to investigate the application of Gentner's structure mapping theory (1980) as a basis for students' construction of concept maps in conjunction with textual analogies. Tenth grade students will receive a simplified introduction to structure mapping theory and learn a modified version of concept mapping to use with texts containing extended analogies. They will generate individual maps via computer for the base (familiar) domains with significant relations and attributes, along with isomorphic second maps corresponding to target domains, with respective relations and attributes. They will identify attributes and relations that do not map (in order to prevent misconceptions). After training they will receive test passages with extended analogies. One week later, retention will be assessed via application and recognition test items. Differences between the experimental group and a control group who do not receive the training will be assessed via a two group and two condition within-subjects ANOVA (split plot repeated measures design) will be employed. Implications for strategy training will be discussed.

A7.15

COGNITIVE CONTROLS WHICH PREDICT SUCCESS IN MIDDLE SCHOOL EARTH SCIENCE: A PILOT STUDY
Jacqueline A. Hykle, University of Cincinnati

The purpose of this study was to examine the relationships between three cognitive controls and achievement in earth science. Studies show the cognitive controls students use significantly differentiate those who are successful from those who are unsuccessful on standardized achievement tests in the areas of reading and mathematics; however, none have been conducted to identify an appropriate cognitive profile for success in middle school earth science. Cognitive profiles indicating where each student is functioning within each of the cognitive control continua were developed. Utilizing cognitive profiles on the analytic, reflective, and focusing cognitive controls, this pilot study did not find any significant linear relationship between students' cognitive profiles and success in middle school earth science. On-going research examining relationships between students' cognitive profiles and success in physical science is also discussed.

A7.15

ENGAGING AND MOTIVATING STUDENTS TO LEARN IN INFORMAL SETTING
Christine Kelly and William Holliday, University of Maryland

The purpose of this research is to study the effectiveness of a multimedia, interactive exhibit series at involving subjects in scientific investigations outside the structure of a classroom environment. Engagement and involvement measures include cognitive variables such as informative discourse, comprehension, problem solving, awareness of time allocation, and motivational factors such as expectation of ability to solve problems, contribution of exhibit to educational / personal goals, and enjoyment of the exhibit. In the study, two populations of University subjects are given an opportunity to interact with multiple, two part, science exhibit series. The first group is assigned to interact with the exhibit, the second group interacts with the exhibit as interested. In the first exhibit, subjects are given a cognitive conflict which requires investigation. Probing questions, as well as motivational and strategic discourse questions are within the display. At varying intervals, a follow-up exhibit then provides tools to solve the conflict. Subjects interaction are again recorded.

A7.15

SCIENCE KNOWLEDGE, COGNITIVE STRATEGIES, AND MOTIVATIONAL ORIENTATIONS ACROSS CULTURALLY AND LINGUISTICALLY DIVERSE STUDENTS.
Okhee Lee and Sandra H. Fradd, University of Miami

The study examined students' problem solving on a series of science tasks by four ethnolinguistic groups of upper elementary grade students: (a) monolingual English speakers, (b) bilingual English-Spanish speakers, (c) bilingual English-Haitian Creole speakers, and (d) monolingual speakers of black vernacular English. In each group, boys and girls and students from various socio-economic levels were equally represented. The study examined science knowledge, cognitive strategies, and motivational orientations, with a focus on commonalities as well differences among these diverse groups. The study was conducted in two schools which significantly differed in language, culture, and socio-economic levels. Using three science tasks, 16 dyads of students were interviewed by teacher-researchers of the same gender, language, and cultural backgrounds. Differences in languages and cultures occurred clearly in interactional styles between the teacher and students and between students. While there were no major language and gender differences in science knowledge, cognitive strategies, and motivation in science, social class and community strongly affected science learning and performance. Implications of the findings for science teaching and learning are discussed.

A7.15

UNDERGRADUATE STUDENT USE OF GRAPHING SKILLS IN THE LEARNING OF MOTION
Michael T. Svec, Indiana University, Bloomington.

The purpose of this study was to investigate how students use graphs in the lab to learn motion concepts and whether or not students can apply the concepts to new non-graphic problems. A multiple-choice pre- and post-test was developed to examine graphing interpretation skills, content knowledge of motion involving graphs and content knowledge of motion involving word, math, and picture problems. Students will also be videotaped during their laboratory exercises to document their use of graphing interpretation skill to make sense of the motion concepts. To establish the impact of graphs, a nonequivalent control-groups design will be employed with the treatment group conducting labs using micro-computer based laboratory activities which emphasize line graphs of one-dimensional motion. An analysis of covariance using interpretation skill as the covariate will be used.The implications for instruction include defining prerequisite graphing skill and refining graphing based labs to advantage the student.

A7.15

QUALITIES OF EXCEPTIONAL SCIENCE TEACHERS: A MODEL FOR TEACHER PREPARATION STRATEGIES.
Susan P Speece, Anderson University

As we embrace the national efforts for science education reform, the preparation of quality science teachers is imperative. Before effective reform based teacher preparation strategies can be developed, it important to know what research tells us about the qualities of exceptional science teachers. The purpose of this study was to examine the qualities possessed by 162 exceptional science teachers. Students enrolled in a variety of courses in the Department of Biological Sciences at Anderson University were given an open-ended questionnaire that asked them to identify the qualities of their best science teacher. The responses fell into five general groups. The majority of the responses dealt with classroom teaching skills, followed by personality traits and then academic abilities. Personal needs of the students and academic needs of the students were collectively not mentioned as often, however, the single most important characteristic dealt with the personal needs of the student. These data differ from previous data collected that pertains to the qualities of exceptional teachers outside the field of science. The results have definite implications on how we approach science teacher preparation.

A7.15

ACHIEVEMENT, GRADE LEVEL, AND GENDER AS PREDICTORS OF STUDENT ATTITUDES TOWARD SCIENCE.
Molly H. Weinburgh, Georgia State University

The purpose of this study was to investigate the relationships of student attitudes toward science with science achievement, grade level, and gender. Six attitudinal variables were studied using a revised form of the ATTITUDES TOWARD SCIENCE INVENTORY (Gogolin & Swartz, 1992). Student achievement, grade level, and gender were used as the predictor variables. The sample consisted of 793 students from the 4th, 7th, and 10th grades. The data indicated that student attitudes became less positive as academic achievement decreased and as grade level increased. Females generally were less positive than males. An ANOVA indicated that academic achievement was a significant predictor for all the scales. Grade level, after controlling for academic achievement, was a good predictor for all of the scales but anxiety and self-concept. Gender, after controlling for academic achievement and grade level, was a good predictor of all the scales but anxiety, value, and motivation. Interpretations and implications are given.

A7.15

THE ROLE OF THE DEMONSTRATION CLASSROOM IN INSERVICE

Julie L.Wilson, The University of Iowa

The focus of this study is to determine the role of the Problem Solving Demonstration Classroom (PSDC) in inservice. There are two major components to this study: 1) assessment of successful implementation, and 2) identified role of the demonstration classroom by the inserviced teacher. Both quantitative and qualitative methods are being used throughout this study. Teacher behaviors are being coded to assess successful implementation, and teachers are participating in focus groups and interviews to provide insight in to the role of the PSDC. Sixty teachers are participating in three demonstration classroom sites that highlight Search, Solve, Create, and Share problem solving in conjunction with math/science; S/T/S; and technology. Ultimately, this study seeks to impact the teaching of problem solving in science education through improved inservice. This will be facilitated directly by this study providing insight into an alternative strategy for inservice and providing preliminary data concerning the role of the PSDC. Locally, data from this study will be used in the development of additional PSDC's and provide guidance for statewide demonstration classroom development.

A7.15

A STUDY OF THE SCIENCE CONTENT KNOWLEDGE AND SCIENCE PROCESS SKILLS OF PRE-SERVICE ELEMENTARY TEACHERS

Joan M. Boorman, Buffalo State College and Rodney L. Doran, University at Buffalo

The purpose of this study was to gain a clearer understanding of the relationship that exists between the high school and college science coursework completed by the pre-service teacher and the elementary science concepts they know, understand, and can apply. Achievement and performance tests used in the SISS were administered to the sample of 318 pre-service teachers, which was drawn from colleges in Missouri, New York, and Texas. Data on high school and college coursework was collected on the sample. Correlations between the dependent measures of achievement tests and performance tests and the various independent variables, including; high school and college science coursework will be discussed.

A7.15

ANALYSIS OF COLLEGE SCIENCE EDUCATION POSITION ANNOUNCEMENT

LLOYD H. BARROW AND CORALEE SMITH, UNIVERSITY OF MISSOURI

The purpose of this study was to analyze college science education teaching positions that were listed in The Chronicle of Higher Education. From August, 1992 through June, 1993, there were 112 listings which included 36 science education positions, 23 with joint science positions and 53 with joint education positions. The majority of the positions being desired were at the assistant or assistant/associate levels. NSTA districts that had the greatest number of advertised positions were districts 2, 6, 7 and 11. Slightly more than half of the announcements required the applicant to have completed the doctoral dissertation. A chi-square analysis found significant differences between display and non-display announcements. More than 75% of the announcements request previous teaching experience but do not specify minimum numbers of years. For institutions which do specify years of experience the mode was three years. Slightly over 50% of the announcements specify student teaching supervision, about 5% indicate inservice, 25% indicate grant writing, and 33% indicate publications are expected.

A7.15

INFLUENCE OF COOPERATIVE EARLY FIELD EXPERIENCE ON PRESERVICE ELEMENTARY TEACHERS' SCIENCE SELF-EFFICACY

John R. Cannon, University of Nevada-Reno
Lawrence C. Scharmann, Kansas State University

The influence of cooperative early field experience on preservice elementary teachers' science self-efficacy was investigated in this study. The population was comprised by 121 preservice elementary education students enrolled in an elementary science methods course. Cooperative learning groups were formed within each of five laboratory sections. Each cooperative group witnessed several modeled science lessons employing cooperative techniques prior to planning and teaching a cooperative elementary science lesson in local public schools. Science teaching self-efficacy scores were obtained from two laboratory sections directly before and three other sections immediately following the performance of a cooperative teaching field experience. An ANOVA was conducted; a significant main effect was obtained ($F = 8.63$; $p < 0.01$) with respect to time of self-efficacy assessment. This finding supported an inference that early cooperative field experience had a positive influence on preservice elementary teachers' science self-efficacy.

A7.15

PROFESSIONAL DEVELOPMENT IN MULTICULTURAL EDUCATION FOR MIDDLE SCHOOL SCIENCE AND MATHEMATICS TEACHERS: POSSIBILITIES AND PROBLEMS

David B. Deru, David F. Jackson, Mary M. Atwater, University of Georgia, and Jenny Penney Oliver, Kansas State University

This is an ongoing case study of an inservice training and reform effort at a professional development school, aimed at familiarizing middle school teachers with principles and practices of multicultural education. Almost all of the teachers at the school are white, while over half of their students are African-American. In this preliminary report we focus on the tension and conflict which many of the teachers feel between a strong desire to better understand and serve their students and the strong doubts, both intellectual and emotional, which many of them feel about adopting attitudes and practices recommended by multicultural educators.

A7.15

ELEMENTARY SCIENCE TEACHING AT ITS BEST: RESULTS FROM A TEACHER ENHANCEMENT PROJECT

Patricia K. Freitag and DeAnn Huinker, University of Wisconsin - Madison & Milwaukee

This evaluation research study reports findings from program evaluation and a cross-sectional study of teaching practices, self efficacy, and science and mathematics teaching confidence of urban elementary teachers. Self efficacy of participants finishing the 2 year integrated in-service program is higher than teachers from the same district entering the revised program. Unique aspects of the program include: integrated sciences and mathematics content presented conceptually and thematically, team teaching and student centered teaching strategies modeled by in-service delivery teams, and active learning strategies. Given the sustained interaction and support of this content and pedagogy program, urban elementary teachers were willing and able to innovate the instructional practices used in their classrooms. Such programs may provide a model for mid-career "practicums" for in-service teachers.

A7.15

MODIFYING AND IMPLEMENTING A "SCIENCE, TECHNOLOGY, AND SOCIETY" COURSE FOR MIDDLE GRADES SCIENCE TEACHERS.

Cindy L. Doherty, Penny J. Gilmer, and Robin H. Marshall, Florida State University

In this study we examine the modification and implementation of a "Science, Technology and Society" (STS) course for middle grades science teachers involved in a teacher-enhancement program. Additionally, constraints to the change process are identified and the impact of the modifications on student attitudes and learning are discussed. This course was previously taught as an upper-level undergraduate STS course. Four factors were instrumental in the revision of this course: 1) to meet the objectives of the program and the needs of the teachers, 2) to effectively accommodate a class of 75 students, 3) to respond to previous course evaluations, and 4) the course would be taught in 5 weeks as opposed to a previous section which lasted 15 weeks. Identified constraints were time, class size, and beliefs about the teaching and learning of science at the college level. A significant shift in student attitudes is attributed to changes in the instructor's teaching style, such as increased group interactions, emphasis on quality of learning versus quantity, and the use of alternative assessments.

A7.15

A CASE STUDY OF PROSPECTIVE ELEMENTARY TEACHERS' BELIEFS CONCERNING EMPOWERMENT IN SCIENCE TEACHING AND LEARNING

Dee French, Thomas Kopalla, Jr., and Elizabeth C. Doster, University of Georgia

The purpose of this research is to probe prospective teachers' beliefs concerning empowerment in learning and teaching science. A qualitative methodology will be used to explore prior beliefs about empowerment and explore issues of empowerment experienced in an elementary science teaching methods course that is taugnt through emancipatory strategies. The theoretical frameworks which form the backdrop of this study include: (a) constructivism advocating learning as an interpretative process involving cognitive constructions of individuals and social collaborations; (b) Habermasian emancipatory interests applied to science education; (c) the literature of empowerment through critique, reflection, and deliberate action; and (d) a growing research base involving teacher beliefs and practices. A case study approach using contextual analysis and grounded theory will identify categories and events. Results showed that (a) students fall on a disempowerment-empowerment continuum that reflects their epistemological position and (b) students experiencing cognitive dissonance resulting from the emancipatory course who then engaged in self reflection exhibited a greater sense of empowerment. Assertions identified beliefs associated with empowerment that teacners can use as a mirror to inform their teaching.

A7.15

EFFECTIVENESS OF A MODEL TEACHER PREPARATION PROGRAM FOR THE ELEMENTARY LEVEL.
Dorothy Gabel and William J. Boone,
Indiana University

To improve the quality of science education at a large state university in the midwest established the Quality Elementary Science Teaching (QUEST) program to prepare prospective teachers more effectively. Although the program is structured to aid all elementary education majors, students are provided with an opportunity to select science as an area of concentration. By doing so students complete 18 additional hours of science, partake in Saturday science experiences for local elementary children, and complete an interdisciplinary capstone course taught by science faculty. This study presents the results of comparing the knowledge and beliefs of students before and after implementation of the new science education program. Data analysis indicate that the two groups do not differ by achievement, cognitive ability, computer attitudes, and high school courses completed, but differences are found in their beliefs about themselves as future science teachers.

A7.15

TEACHER ENHANCEMENT COLLABORATION: COOPERATION OR A PARTING OF THE WAYS?
Sandra Henderson and Norman G. Lederman, Oregon State University

The purpose of this study was to determine if differences exist in how scientists and science teachers participating in science education partnerships perceive the current goals of science education. If differences between the two groups do exist, discovering and understanding the differences in perceived goals at the outset will allow teacher enhancement programs to be designed in a way that recognizes the differences and takes steps to be certain that the overall objectives of partnership programs are not subverted during the planning and implementation process. Using a survey instrument based on the goal statements from NSTA and AAAS relating to contemporary science instruction, subjects were asked to rank the goals in order of importance. The results of the study suggest that some differences do exist in how scientists and science teachers perceive pre-college science instruction.

A7.15

A CASE STUDY OF ELEMENTARY TEACHERS: PERCEIVED INTERACTIONS OF PROFESSIONAL INQUIRY AND SCIENCE CURRICULUM PRACTICE
Alison Graber, Northern Arizona University

This interpretive case study focuses on teachers' perceptions of the interaction of professional inquiry activities and science curriculum practice. Interviews, questionnaires, and teacher constructed science modules were the major sources of information for the case study. Teachers' sought out topics/ideas for science through a variety of professional inquiry opportunities that usually offered curriculum materials usable in their classrooms. The "conduit" of science reform connected to the school through a variety of avenues, such as university summer institutes, state curriculum documents, and curriculum materials. Teachers' reconstructed the meaning of reform recommendations within the school setting in ways different from the intentions of reform recommendations. The school science curriculum consisted of a series of modules based on topics that were integrated into language arts and math. There appears to be a gap between the "intended" practice advocated by the science education reform community and the "enacted" curriculum within this elementary school. There needs to be a greater focus on curriculum development and practice within the school context in order to understand the competing influences on elementary science curriculum practice.

A7.15

THE USE OF A STRUCTURED DISCUSSION STRATEGY TO FACILITATE CONCEPTUAL CHANGE ABOUT MAGNETISM WITH PRE-SERVICE TEACHERS. Carol Lena Lane, University of Georgia.

This study explored the concepts of pre-service early childhood education majors about magnetism through the use of a hermeneutic dialectic process. A written pretest with both open-ended and structured questions was administered. Scientifically unaccepted concepts and gaps in knowledge were identified and addressed with hands-on activities. Students then participated in a structured discussion. Written statements about the concept of magnetism showed their understanding after the activities, after the discussion, and at the end of the quarter. Semi-structured interviews using open-ended questions probed their conceptual understandings. Transcripts of the discussions, interviews, and written statements were analyzed to trace their conceptual change.

A7.15

INCREASING CALIFORNIA'S ETHNICALLY DIVERSE SCIENCE TEACHER POOL: YEAR 1
Cathleen C. Loving, Texas A&M University
James Marshall, California State University, Fresno

Project MOST is a five-year project to recruit, nurture, educate and credential ~65 ethnically diverse science teachers for California's Central Valley. Whereas the majority of students in the schools of the Central Valley are Hispanic, Southeast Asian, and, to a lesser extent, African-American and Native American--and some rural districts are over 95% Hispanic--the number of middle or high school science teachers from these ethnic groups is tiny. In most districts there are none. This research focuses on evaluation of the inaugural year of the project where twelve high school seniors were recruited. Evaluation results were used to launch an improved year two with twenty-five recruits enrolled in the 1993-94 program. Multiple methods of qualitative and quantitative evaluation were used to determine degree of perceived importance and effectiveness of "bridge" programs, peer counseling/tutoring, professional counseling, cohort interaction, academic innovations, and science teacher mentoring. Results indicate the role of the professional counselor in recruitment/retention is more multi-faceted than anticipated for student success; bonding of multi-ethnic groups and attitude shifts as the result of science teacher and peer counselor mentoring appeared important; and early involvement of science faculty with California Science Framework tenets helped shift perspectives.

A7.15

MAKING CONNECTIONS IN SCIENCE KNOWING AND SCIENCE TEACHING: A STUDY OF TEACHER-LEARNING AT AN ELEMENTARY PROFESSIONAL PRACTICE SCHOOL SITE.
Sharon Nichols, Betsy Sullivan, and Aldrin Sweeny, Florida State University

This interpretive study takes a qualitative look at prospective and practicing elementary teachers and university graduate students involved in collaborative classroom research. Issues are raised concerning the teachers' prior science learning experiences and constraints perceived in classroom teaching. The university-school partnership provides a model to include teacher education as key element to systemic reform in science education.

A7.15

USE OF LEARNING ENVIRONMENT SURVEYS IN AN INTERPRETIVE RESEARCH ON A COLLEGE BIOLOGY COURSE FOR PROSPECTIVE ELEMENTARY TEACHERS.
Hedy Moscovici and Kenneth Tobin, Florida State University

The purpose of this study was to find the relationship between how students perceive their environment in a newly developed biology college course for prospective elementary teachers and their commitment to learn. Students completed the Classroom Environment Survey, and on the basis of a cluster analysis of their responses, four groups were identified. One student was selected from each group as a data source for follow-up qualitative research. Interviews, classroom observations, videotapes, transcripts and artifacts were the sources of qualitative data. Five dimensions were used to characterize the learning environment: involvement, autonomy, relevance, commitment, and inhibitors to learning. The research shows that, with the exception of relevance and commitment, there was a close fit between the environment preferred and the environment experienced. Students preferred the environment to be more relevant , especially to teaching elementary science, than was experienced. In the instances of autonomy and involvement there are some implications for the good fit between preferred and experienced.
Qualitative data helped us understand students' cultural meanings behind their survey responses, uncovering cultural differences, and issues related to students' construction of self in this specific college biology classroom for prospective elementary teachers.

A7.15

A COMPARISON OF THE PERCEPTIONS OF ELEMENTARY PRESERVICE TEACHERS ENROLLED IN TRADITIONAL SCIENCE METHODS COURSES AND THOSE ENROLLED IN TEACHER EDUCATION CENTER COURSES
Kathenne Norman, The University of Texas at Brownsville

The purpose of this study was to compare the perceptions of (a) preservice teachers enrolled in a traditional science methods class and (b) preservice teachers enrolled in a center science methods class. Perceptions were examined with regard to the value of concepts and skills addressed during the courses and student attitudes, knowledge, and confidence levels before and after taking science methods.

Students in the traditional science methods class spent three times longer in the university classroom than students in the center methods class. However, center students participated in extended field experiences in elementary schools three days each week during the semester. Students in the traditional group participated in a 16 hour field experience during the semester.

Students in both groups gave similar value ratings to the concepts and skills taught in the courses. Center students reported more positive attitudes about teaching science both before and after the course, but students in the traditional class reported a greater gain in attitudes about teaching science after the course. Center students rated their overall knowledge about science teaching higher than students in the traditional group. Students in both groups reported similar confidence levels.

A7.15

DEVELOPING CURRICULUM FROM A CONSTRUCTIVIST PERSPECTIVE.

Helen Parke, Charles Coble, Floyd Mattheis, and Michael Vitale. East Carolina University

A fundamental premise of any science curriculum development project is that the philosophical intent of the curriculum will be realized in the classroom as it is incorporated into the learning experiences of students. To support the view that if teachers understand the program philosophy they will deliver the program as intended, the Scope, Sequence, and Coordination Project in North Carolina involved teachers in the writing process, in intensive staff development, and in classroom implementation. From a constructivist perspective on learning, curriculum developers relied heavily on concept mapping and consultations with scientists to clarify their own understandings and to make connections within and across science disciplines as they designed preliminary teacher materials. The curriculum framework then became the vehicle through which teachers made a philosophical shift that impacted their belief system about learning and teaching. Evidence from classroom observations and from interviews with teachers indicates that the concepts constructed by the curriculum writing team in the earliest phases are similarly being constructed by students through investigations, conversations, and questioning techniques initiated by their teachers. This session will share the process of using these metacognitive strategies.

A7.15

IMPLEMENTATION OF SUMMER INSERVICE ACTIVITIES: A CASE STUDY COMPARISON

Dana Riley, Jane Butler Kahle, and Ann Haley-Oliphant, Miami University

The purpose of this study was to evaluate the implementation of the inservice program, Teaching Science with Toys, (TOYS). The study consisted of two case studies conducted at elementary schools in midwestern and western states. The methods used to acquire data for the case studies included field notes from classroom observations and structured interviews with both teachers and students. The study evaluated and compared the amount and types of inservice activities implemented, observable student outcomes, as well as both student and teachers' modifications in attitudes and beliefs. By comparing the data from the two case study sites, distinct differences contributing to variations in the inservice implementation emerged. These variations included support from both the inservice program and the case study sites as well as the particular "culture" of each case study site. Recommendations for successful inservice implementation including sustained support and site-specific considerations are suggested for this and other inservice programs.

A7.15

AN EXPLORATORY STUDY OF HOW ONE SCIENCE EDUCATOR CONTRIBUTES TO PRESERVICE ELEMENTARY TEACHERS' CONFIDENCE IN THEIR SCIENCE TEACHING ABILITIES

Diana C. Rice, University of South Carolina-Aiken and Anita Roychoudhury, The Miami University of Ohio-Hamilton

The purpose of this exploratory study was to identify teacher practices in an undergraduate elementary science methods course which constrain or facilitate the development of preservice teachers' confidence in their ability to teach science. The setting of the study was two sections of elementary science methods with a total enrollment of 53 students. Class meetings were videotaped for teacher reflection and analysis with a peer collaborator. Student input into the research process was obtained through written reflections, course evaluations, interviews with students, and from anecdotal comments. Several assertions about the impact of the teacher on the development of students' confidence and about constraints which hindered this development emerged through this process.

A7.15

CHEMISTRY FOR ELEMENTARY TEACHERS

Tom Elliott, Linda C. Grynkewich, Carol L. Lane

ESC 442 is the science methods course for Early Childhood majors. The objectives of the course are to introduce preservice Elementary teachers to philosophies and strategies of teaching science and to increase their science content knowledge so that they will become more comfortable teaching the subject. When asked during intake interviews which area of science they are least comfortable with or which do they need the most improvement in, most have answered, "Chemistry." We have therefore identified a need to increase the students' awareness of chemistry, appropriate for instruction at the elementary grade level and to promote a positive attitude toward chemistry. The performance-based assessment involves higher order thinking skills and is uniquely open-ended. This research is a study in the effectiveness of the instruction and assessment components of the chemistry unit developed for implementation.

A7.15

TELECOMMUNICATIONS AND THE PRE-SERVICE SCIENCE TEACHER: THE EFFECTS OF USING ELECTRONIC MAIL AND A DIRECTED EXPLORATION OF INTERNET ON ATTITUDES

J. Russett, University of Nebraska-Lincoln

Two primary questions were addressed in this study dealing with telecommunications and pre-service teachers. (a) What effect will the purposeful use of telecommunications in a science methods/curriculum course have on student attitudes towards the usefulness of electronic communications? (b) What will this do to their anxiety level dealing with technology in general?

Primary data was from surveys and student journal entries. Pre and post surveys showed: 1) a marked decrease in anxiety in the experimental group; 2) an increase in both desire to use telecommunications in the classes they teach and in perceived value of telecommunications was found in the experimental group; 3) the students in the experimental group showed a desire to use the INTERNET as a tool for student acquisition and dissemination of information as well as for communication with peers, while the control group wanted to talk about telecommunications.

A7.16

CONSTRUCTIVISM IN THE ATLANTIC SCIENCE CURRICULUM PROJECT

John Barnett, Ontario Institute for Studies in Education and Charles McFadden, The University of New Brunswick

SciencePlus is a constructivist, STS school science program developed by the Atlantic Science Curriculum Project for students 11 to 15 years old. Various editions of the program are used in Canada and the United States. One of the features of the curriculum materials is that they elicit the students' prior knowledge, engage the students in contextually relevant activities and help them construct new conceptual frameworks. How the principal participants in the project came to employ a constructivist model of learning and how they incorporated it into a textbook is the object of this work in progress.

One problem with using a constructivist pedagogy in a curriculum project lies in the necessity of producing actual classroom materials for students to use. Such materials may be used in a prescriptive way by teachers unfamiliar with the program's aims. A second facet of this case study is therefore an examination of the methods of teacher development used to empower them to teach in a constructivist way.

A7.15

INTEGRATING THE ORGANIC AND THE MECHANISTIC TRADITIONS OF ECOLOGY IN THE MIDDLE SCHOOL CLASSROOM: A CASE STUDY

Doris B. Ash, University of California, Berkeley

We describe research illustrating how curriculum design was accomplished by integrating principled ideas from within the historical and philosophical foundations of ecology. First, we outline the mechanist and organicist frameworks, two traditions that co-define ecology. Next, we suggest several important principles that accompany proposed integration, for example, the notion of mutual interdependence of ecosystem components (Worster, 1977; Odum, 1963). Last, we describe research that focused specifically on children's collaborative research of the causes for endangered species status in a wide variety of student-selected animals, during three iterations of an environmental science learning cycle in an inner city school. The majority of the students were academically at risk with more than 80% bilingual or bidialectical.

Research encompasses three stages, and uses an innovative design philosophy (Brown et al, in press). Analyses combine both qualitative and quantitative assessment formats in order to more completely describe the complex world of the classroom. Qualitative methodologies include clinical interviews (Ash, 1991), that act as in-depth pre and post intervention assessments of children's reasoning about complex ideas and discourse analysis.

A7.16

PROGRESSIVE TRANSITIONS FROM ALGORITHMIC TO CONCEPTUAL UNDERSTANDING IN STUDENT ABILITY TO SOLVE CHEMISTRY PROBLEMS: A LAKATOSIAN INTERPRETATION

Mansoor Niaz, Universidad de Oriente

The main objective of this study is to construct models based on strategies students use to solve chemistry problems and to show that these models form sequences of progressive transitions similar to what Lakatos in the history of science refers to as progressive 'problemshifts' that increase the explanatory/heuristic power of the models. Results obtained show the considerable difference in student performance on chemistry problems (mol, gases, solutions, and photoelectric effect) that require algorithmic or conceptual understanding. The difference between student performance on algorithmic and conceptual problems can be interpreted as a process of progressive transitions (models) that facilitate different degrees of explanatory power. This reconstruction of student strategies (progressive transitions) can provide the teacher a framework to anticipate as to how student understanding could develop from being entirely algorithmic to conceptual.

A7.16

TOWARD A BETTER UNDERSTANDING OF STUDENTS PERCEPTION OF SCIENCE, SCIENTISTS, AND THEIR WORK

Hsiao-Ching She, National Taiwan Normal University

The purpose of this study was to examine how the different grade level students related to their perception of science, scientists, and their work. The interview-about-instance (IAI) procedure were utilized to interview Grade 1, 3, 5 and 8 total 297 students with 30 pairs of illustrations concerned with the physical appearance, gender, work tasks, workplace, and employment of scientists. Results showed that different grade level students made different initial responses in relation to most of the illustrations (22 out of 30 items). Moreover, from the comments of their initial responses revealed an increase in sophistication across the four grade levels. Lower grade level boys and girls made similar initial responses to most of the illustration, and higher grade level students revealed an increase difference between boys and girls ideas on scientist appearance items. It seems that school environment has some degree of influence on Grade 1 than other grade level students.

A7.16

RESEARCH IN THE TECHNICAL EDUCATIVE SYSTEM OF THE COUNTRIES THAT COMPRISE THE SOUTH AMERICAN COMMON MARKET

Jorge Bueno, Nelly Diaz, y Nancy Pere, Ministerio de Educación y Cultura del Uruguay, Uruguay

Spanish abstract may be found under session number S4.08.

A7.16

THE UTILIZATION OF HYPERTEXT TOOLS IN THE DEVELOPMENT OF DIDATIC COMPUTER RESOURCES FOR THE TEACHING OF SCIENCE

Luciano Barragan, Universidad Central de Venezuela, Venezuela

Spanish abstract may be found under session number S7.08.

A7.16

REGIONAL PROGRAM OF JUVENILE SCIENCE AND TECHNOLOGY

Jorge Bueno, y Nelly Díaz, Ministerio de Educación y Cultura del Uruguay, Uruguay

Spanish abstract may be found under session number M7.08.

A7.16

RESEARCH MANAGEMENT IN PERU AND THE PETROLEUM INDUSTRY
Esteban Castellanos, International Development Research Center y Universidad Católica del Peru, Peru

Spanish abstract may be found under session number T2.08.

A7.16

BILINGUAL MEMORY: STRUCTURE VERSUS MENTAL PROCESSES
Roberto Heredia, University of California, Santa Cruz, U.S.A

Spanish abstract may be found under session number S4.08.

A7.16

A POSTGRADUATE PROGRAM OF MEAT BOVINES: AN OPTION FOR THE THE ZONE OF THE SEA OF CORTEZ
Rafael de Luna de La Peña, C. H. Hernández, V. J. Espinoza, H. A. Palacios, Universidad Autónoma de Baja California Sur, México

Spanish abstract may be found under session number M7.08.

A7.16

A GENERAL GUIDE FOR THE IMPLEMENTATION OF COMPUTER CAREERS IN LATIN AMERICA
Ramón Mata-Toledo, Carols A. Reyes-García, y Raúl A. Sánchez-Guerrero, James Madison University, Virginia, Instituto Tecnológico de Apizaco, Mexico y Universidad Nacional Experimental del Táchira, Venezuela

Spanish abstract may be found under session number S7.08.

A7.16

DEVELOPMENT OF BASIC MATHEMATICS COMPUTATION ABILITIES: A CENIDET EXPERIENCE
J.L. Ramirez, Manuel Juarez, y Luis Villalobos, Centro Nacional de Investigación y Desarrollo Tecnológico, Mexico

Spanish abstract may be found under session number S7.08.

A7.16

NEW MARINE BIOLOGY STUDENTS IN THE AUTONOMOUS UNIVERSITY OF SOUTH BAJA CALIFORNIA
C. J. Villavicencio Garayzar, y María del Cannen y Gómez del Prado Rosas, Universidad Autónoma de Baja California Sur, México

Spanish abstract may be found under session number S4.08.

A7.16

FARMING AND ANIMAL HUSBANDRY EXTENSION COURSES: A FUNDAMENTAL PEDAGOGICAL EXPERIENCE
R. Santos, Universidad Autónoma de Baja California Sur. México

Spanish abstract may be found under session number M7.08.

A7.16

MODULAR STRUCTURE OF AN INTELLIGENT TUTORIAL SYSTEM IN THE TEACHING OF THEORETICAL AND PRACTICAL DISCIPLINES
Faisal Zeidan, Universidad de Los Andes, Venezuela

Spanish abstract may be found under session number S7.08.

A7.16

THE EFFECTS OF A PEDAGOGICAL MODEL ON THE DEVELOPMENT OF THE AFFECTIVE DISPOSITIONS RELATED TO CRITICAL THINKING.

Nicole Ferguson, Ministry of Education, New Brunswick

The purpose of this study was to examine the level of development of the affective dispositions related to critical thinking in Grade 7 science students following a period of instruction using the pedagogical model called the *Learning Cycle*. Furthermore, the study examined the development in formal thinking and in science process skills. Eight, 7th grade teachers expressed interest in participating in this research. Four of the teachers received inservice in using the *Learning Cycle*. Those same teachers communicated weekly by e-mail with the researcher, exchanging lesson plans and ideas regarding the use of the *Learning Cycle*. The other four teachers followed their normal program. The eight teachers were visited periodically by the researcher. Pre and posttests were administered to 450 students measuring their affective dispositions in critical thinking using the *California Critical Thinking Dispositions Inventory* (CCTDI) questionnaire, their development in logical thinking using the *Group Assessment in Logical Thinking* (GALT) questionnaire, and their performance in science process skills using the *Test of Integrated Science Process* (TIPS II).

A7.16

THE RELATIONSHIP BETWEEN GIRLS' PERCEPTIONS OF PHYSICS, CLASSROOM INTERACTIONS AND GIRLS' ACHIEVEMENT IN PHYSICS.

Bernadeta K. Mushashu, University of New Brunswick

Previous studies of sex differences in academic achievement have identified early childhood experiences, socialization, family background, ethnicity, biological factors, teachers and curriculum as factors affecting girls academic performance in science. The fact that these factors did not affect girls' achievement in those years, shows that there may be something wrong in secondary schools which greatly affects girls' achievement. Girls' perceptions about physics, together with secondary teacher-student interaction might be the main cause for girls' underachievement in physics. This paper examines gender differences in perceptions of physics, the nature of co-ed classroom interactions, and relationship of these two factors, with girls' achievement in secondary school physics. Two hundred and ten students completed the questionnaire, 6 teachers were interviewed and classroom interactions were video recorded. The preliminary results indicate that there is a differential treatment between boys and girls in physics classrooms.

A7.16

DESCRIBING TANZANIAN SECONDARY SCHOOL STUDENTS' UNDERSTANDING OF SCIENCE AND THE IMPACT OF SCIENCE ON SOCIETY.

Mwantumu M. Hussein, University of New Brunswick.

Most changes in Tanzanian science curricula are made in the absence of adequate feedback from the schools. In addition, only limited research is available about science education at secondary school level. Exploring students' understandings of science will provide information to our decision makers and point out any need to change our science curriculum or ways of teaching. The purpose of this study was to describe a group of secondary school students' understanding of science and the impact of science on society. The study was conducted in Mwanza district in Tanzania. Two focus groups of eight science taking students each were interviewed in three sessions. Each session was video recorded. Dialogue journals were also established between the participants and the researcher. Data analysis involved categorizing the data into meaningful themes and patterns. Preliminary analysis and results show the kinds of understandings students posses about science and their awareness of the relationships between science and society.

A7.16

WHAT OPPORTUNITIES AND CONSTRAINTS DO YOUNG FEMALE SECONDARY SCHOOL TANZANIAN STUDENTS REPORT ABOUT THE STUDY OF SCIENCES?

Anisia Nenze, University of New Brunswick.

In Tanzania women are under-represented in science fields of work and in the science classrooms as teachers and as students, especially in high schools and colleges. However women are the daily users of science in the homes and in agriculture. The nation encourages all students to pursue science at all levels of education. Why do girls more than b s shy away from science options as a requirement for their future careers in life? The purpose of this study was to describe young female Tanzanian students' perceptions about the study of science in secondary school. Two focus-groups of six students each were interviewed in four sessions; each session was video-recorded. During the study, a dialogue journal was established between the interviewer and the interviewees. Member checking was also undertaken by discussing video-tape replays. Data analysis involved categorizing the data into meaningful themes. Patterns and inter-relationships were sought within and among the categories. Outcomes of preliminary analysis will be presented.

A7.16

TRAPS IN CHEMISTRY LEARNING - STUDENTS' DIFFICULTIES WITH THE OXIDATION CONCEPT

Hans - Jurgen Schmidt, University of Dortmund, Germany

The purpose of this descriptive study was to uncover how senior high school students use the term redox reaction. Multiple-choice questions with distractors reflecting students' misconceptions were developed. A sample of 4,970 German senior high school students completed the tests. The students were asked to give reasons for their answers. The results of the study show why students chose distractors rather than the correct answers of the multiple-choice tests. They try to use characteristics of the old oxidation concept with the new one, assuming that oxygen is involved in every redox reaction. An analysis of two American and two German chemistry textbooks for senior high schools showed that the modern concept of oxidation is introduced. However, only a limited form of the oxidation concept is used afterwards. It is therefore reasonable to ask whether only the limited forms of these concepts should have been introduced in the textbooks and also used in chemistry teaching. In any case, teachers should be aware of students' difficulties with ambiguous terms. In chemistry, as well as in other natural sciences, more research into student misconceptions caused by ambiguous terms should be conducted.

A7.16

TEACHING ELECTRICITY: A CURRENT DILEMMA

Susan M Stocklmayer and David F Treagust, Curtin University of Technology, Perth, Australia

Research findings indicate that students' understanding of simple electric circuits is confused by many alternative conceptions. The model of electric current which is presented in most textbooks is fundamentally newtonian in nature. Many teaching strategies focus on this model as the analogical target for students' understanding, but the persistence of alternative conceptions indicates that the model is a difficult one for students. For practitioners in electrical technology, however, a field concept has been found to be the most useful model. This paper describes a classroom initiative to teach elementary circuitry to secondary school students using a field-based model. The relevance of this model to current teaching practice is discussed in this paper.

A7.16

THE ROLE OF SEMANTICS IN STUDENTS' CONCEPTIONS AND RESEARCHERS' INTERPRETATIONS

David Schuster, University of Natal, Durban, South Africa

The role of semantic factors in students' conceptions in science and researchers' interpretations thereof is insufficiently recognized. Word usage, phrasing and contextual meaning can play an important role in helping or hindering student understanding of scientific concepts. It will also be argued that certain 'misconceptions' arise from semantics as much as from concept misunderstanding. Furthermore, researchers' characterizations of student conceptions have sometimes been based on semantic misinterpretations. Treated as hypotheses, the above statements were tested by comparing student responses to conventional misconceptions tests based on named concepts like 'force', 'velocity' and 'acceleration' with responses when the concept names were replaced with more fundamental but scientifically equivalent phrasing. Responses were often significantly different, indicating that semantic issues have implications for the interpretation of conceptual understanding. This suggests reconsideration of some earlier misconceptions findings. The effect of initial teaching using fundamental phrasing rather than concept names was also investigated; the approach helped to develop operational conceptual understanding while diminishing misconceptions.

A7.16

SELECTED STUDENT FACTORS AFFECTING ACADEMIC ACHIEVEMENT OF GRADE 8 STUDENTS IN BHUTAN

Chogyal Tenzin, University of New Brunswick

A great need for research in student achievement is felt in Bhutan, where little has been done in this area; the education system relies largely on research evidence generated in other countries. This paper describes a study of how selected student variables--age, gender, father's occupation, home location, residence status and type of school attended--influence student performance in science, mathematics and overall academic achievement in Bhutan. The sample consisted of 765, grade 8, students in 3 high schools and 11 junior high schools. Achievement was measured by scores obtained from the Bhutan Junior High School Leaving Certificate Examinations (BJHSCE) conducted by the Bhutan Board of Examinations (BBE) in 1989. The Statistical Analysis System software was used to correlate the independent student variables with achievement variables. Multiple Regression Analysis was performed to determine the combined effects of the student variables on achievement. The data consist of student background information obtained from the Planning Division of the Department of Education and the result sheets of the 1989 BJHSLCE Examinations conducted by BBE.

A7.16

MATHEMATICS/SCIENCE TEACHER, TEACHER/RESEARCHER, CONSTRUCTIVIST: MULTIPLE ROLES AND MULTIPLE DILEMMAS

Loren R. White, Curtin University of Technology

The purpose of this study was to examine: (1) the roles of a teacher/researcher and the frameworks required to adequately describe the merging of roles, (2) the effects of collaborative research on the teacher/researcher, students and academic researcher, and (3) a teacher/researcher's attempts to merge science and mathematics in a grade 8 mathematics classroom. This collaborative case study involved reflective journal entries, inclass interviews with students, observer field notes, and discussions between the teacher/researcher and the academic researcher. Ongoing analysis of the data revealed the nature and content of a coherent description of classroom incidents depended on which of the multiple roles the teacher adopted. No one role, but rather an emergent, not clearly explicated additional perspective was required. From such an emergent role arose ethical dilemmas for the teacher in relation to decisions made in the act of teaching and how they affect student learning, the outcomes of the project and the success of the collaborative research process. Further, in relation to these points, it was found that judgement of the success of the attempts to merge science and mathematics also depended on which role/perspective was adopted.

A7.16

EVALUATION OF A RESEARCH BASED IN-SERVICE PROGRAM.

Ellen van den Berg, University of Twente, The Netherlands

The aim of our study is designing a research based teacher program to improve the quality of science education at the elementary school level. The main goal of the training is changing teachers' beliefs of science education and their teaching behavior from a more traditional toward a more innovative approach. In the first part of the paper a justification and the outline of the training program will be presented and illustrated with a short video-program, in which the training's main ideas have been epitomized. The second part summarizes the results of a formative evaluation. In the third part the effects of the training on teachers' attitudes and behavior will be presented. The last part the results will be discussed.

A7.16

REVERSING A LINE OF THOUGHT IN ORGANIC CHEMISTRY

Vijay Reddy, University of Natal, Durban. South Africa.

This is research in progress. Reversibility of a mental process means a reconstruction of its direction in the sense of switching from a direct to a reverse train of thought. Reversing a line of thought is an important cognitive skill necessary for understanding concepts in organic chemistry. This research was conducted with students taking chemistry 1 at the University of Natal (South Africa). The purpose of the study was to determine students' current proficiency in the skill (reversing a line of thought). the level of proficiency required to ensure understanding of certain organic chemistry concepts and to determine the kinds of prompts or scaffolding that could be offered to students to facilitate that understanding. Students were given problems relating to ozonolysis of alkenes to solve. They were asked to think aloud as they solved the problems. The interviews were involved interaction between student and interviewer and prompts to solving the problem were offered. "Successful students" (having done well in mid year exams) as well as students who came from disadvantaged schooling systems were interviewed and a model of reversible thinking skill will be developed.

A7.16

COOPERATIVE EVALUATION AND THE USE OF NEW TECHNOLOGIES IN SCIENCE PROJECTS IN A MIDDLE SCHOOL SETTING.

Pierce Farragher, Nikki Burger, University of Victoria, and Colin Collister, Bayside Middle School, B.C. Canada

The subject of this presentation is an action research project which had the following foci: (i) An examination of the concepts involved in problem-solving (skills/processes, attitudes, knowledge, and critical thinking). (ii) Cooperative evaluation of a science project by students and teachers. (iii) Previously learned technology skills (i.e. Hypercard, graphing, wordprocessing, etc.) that students might use in a selected science project. (iv) changes in students attitudes toward science. The projects were selected from three domains: Forestry, Agriculture, Fisheries. Log books were maintained by 70 Grade 8 science students. Pre and post science attitude surveys were completed and students were interviewed to explain their selections and evaluations. Matched pairs of t-tests were done to compare pre and post attitude surveys on several variables and a reliability analysis was done on the substrate variable. Significant differences were found between the teachers' evaluation of the students, the students evaluations of themselves, and of each other, with the teachers evaluations being significantly lower than the other two groups. Highly significant positive changes in students attitudes toward science were also recorded. It was noted that Grade 8 science students require much guidance and encouragement in the development of their skills/processes, attitudes, knowledge, and critical thinking.

S2.01

STUDENT DISENGAGEMENT IN MIDDLE SCHOOL SCIENCE CLASSES: CONSEQUENCES FOR AFRICAN-AMERICAN FEMALES

Mary Antony, University of Michigan, Ann Arbor

The classroom processes that result in student disengagement are the focus of this interpretivist study. Disengagement is conceptualized as withdrawal or alienation of both teachers and students from the learning process. Through observations and interviews, the study describes the patterns of teacher-student interactions and negotiations that formed the context for learning in four eighth-grade science classrooms. The researcher explores the advantages and disadvantages of this disengagement from both the teacher's and students' perspective. Consideration is given specifically to the consequences of this disengagement for African-American girls.

S2.01

LISTENING TO DIVERSE STUDENTS IN AN HISTORICALLY RACIST REGION: A SOCIAL CONTEXTUAL STUDY OF SCIENCE TEACHING.

J. Randy McGinnis, University of Maryland at College Park.

The purpose of this study was to provide a narrative description and interpretation of students' perceptions of the actions resulting from decision-making of two White science teachers in an urban multicultural middle school situated in the Deep South. The theoretical reference used in this study was constructivist; the research methodologies were qualitative and social contextual. Interactions between the teachers and students made up a consensual domain which defined the learning field. Student participants of this study were African-American, Asian (Chinese, Cambodian, Korean, Japanese, Thai, and Vietnamese), Romanian, Hispanic, Middle Eastern, and mainstream White. Insights from the study include the identification of a tension resulting from the historically oppressed African-American ethnic group's resistance to assimilation into a mainstream culture and teacher and new immigrant students' expectations. The result was a science teaching environment interpreted through significantly different student lenses colored by ethnicity and historical racism in a social context.

S2.01

FORMATIVE EVALUATION WITHIN A PROGRAM TO INCREASE MINORITY PARTICIPATION IN SCIENCE TEACHING AND LEARNING.

Dorothy Rosenthal, Ardra M. Grubbs, and Julia A. Lee, California State University–Long Beach

Throughout the administration of Project MOST, a three-year program to provide Minority Opportunities in Science Teaching, we have been conducting formative evaluations that provide immediate feedback, identify problems, and lead to solutions. For example, when decreasing attendance at sessions four and five of a six-session series was noted, a change in the payment schedule for participants was suggested, so that stipends would increase with each session attended. Another observation was that the ethnic identities of students participating in the Laboratory Assistant component did not match the ethnic group proportions of all Project MOST students. While Asian, Hispanic, and Black students each comprised approximately 33% of all MOST students, within the Laboratory Assistant component the proportions were 67% Asian, 25% Hispanic, and only 8% Black. Further evaluation revealed that Black students were most likely to attend high schools with meager science-laboratory facilities, a barrier to participation not easily overcome. Nevertheless, some recommendations to increase participation in the Laboratory Assistant component were made. These are two examples of the role of formative evaluation within Project MOST.

S2.02

CHILDREN'S' PERCEPTIONS ABOUT TECHNOLOGY: AN INTERNATIONAL COMPARISON

Tina Jarvis, University of Leicester, and Léonie J. Rennie, Curtin University of Technology

This paper compares the perceptions about technology held by elementary school children in Australia and the United Kingdom. Children's perceptions were measured using a Writing/Drawing Activity, designed for children of all ages, a Picture Quiz, designed for young children, and a Questionnaire designed for older children. In each country, samples of about 800 children in second to sixth grade were chosen from schools representative of those in their region. The results indicate that children have an enormous variety of ideas about technology, which become more complex and coherent as they became older, but many children associate technology only with computers and modern appliances. Children's attitudes are positive, although their expressed interest seems to decline with age. The genesis of technology from a craft base in the United Kingdom is reflected by an emphasis on model-making, an aspect virtually ignored by Australian children. The diverse views children hold underscores the importance for teachers of accommodating children's understandings and perceptions when designing their classroom instruction.

S2.02

CHEMISTRY PROBLEM-SOLVING ABILITIES: GENDER, REASONING LEVEL AND COMPUTER-SIMULATED EXPERIMENTS.
Jerry P. Suits , Southern Illinois University at Carbondale and J. J. Lagowski, The University of Texas at Austin

Two studies were conducted to determine the effects of gender, reasoning level, and inductive and deductive computer-simulated experiments, CSE, on problem-solving abilities in introductory general chemistry. In the pilot study, 254 subjects were randomly assigned to control (CAI tutorials), inductive or deductive CSE treatments for the entire semester. On the comprehensive final examination, 78 % problem-solving items, formal reasoners outperformed transitional reasoners who, in turn, outperformed concrete reasoners, ANOVA, $p < .0001$, and males outscored females, $p = .0452$. On gain in reasoning ability among the concrete reasoners, those in the inductive group tended to outgain those in the other two groups, $p = .0676$. For the main study, 187 subjects and no control group, the CSE's were revised to make the structure more explicit. No significant differences were found among the types of reasoners on three cognitive levels of the final examination, although formal reasoners tended to outscore concrete reasoners on middle cognitive items, $p = .1316$. In a reversal of the expected gender differences, males tended to score higher on lower cognitive items, $p = .0814$, whereas females tended to score higher on higher cognitive items, $p = .1411$. We discuss the relationship between problem-solving abilities and the use of guided discovery and interactive CSE's.

S2.03

LEARNING ENVIRONMENTS AND STUDENT OUTCOMES IN SENIOR HIGH SCHOOL BIOLOGY CLASSES
David G Henderson, Launceston College, Tasmania and Darrell L Fisher and Barry J Fraser, Curtin University of Technology

This study investigated associations between students' achievement and attitudinal outcomes and their perceptions of the classroom and laboratory learning environments among a sample of 489 students from 28 biology classes in 8 schools in Tasmania, Australia. The *Questionnaire on Teacher Interaction (QTI)* was used to assess interpersonal behavior between teacher and student and the *Science Laboratory Environment Inventory (SLEI)* provided student perceptions of their science lab-classes. Achievement on an external examination, performance in practical tests and responses to two attitude questionnaires were used as student outcome measures. Past research was replicated in that sizeable relationships were found between the environment and outcome measures, although associations were stronger with attitudinal outcomes than with cognitive or practical skills outcomes. Commonality analyses suggested that the QTI and SLEI each made an appreciable contribution to the variance in outcomes which was independent of the variance attributable to the other instrument. Some statistically significant gender differences were found in students' responses to QTI and SLEI scales.

S2.02

AN EXAMINATION OF MIDDLE SCHOOL STUDENTS' DECISION-MAKING ON MUNICIPAL SOLID WASTE MANAGEMENT IN TAIWAN
Kuo-Hua Wang, National Chunghua University of Education, Taiwan

This study examined eighth-grade students' conceptions on solid waste management. A process-tracing techniques by using a HyperCard simulation on solid waste management have been used in this study to assess the students' cognitive process in a decision-making. Twenty seven students participated in the study. The result showed that 11 (40.7%) out of a total 27 students succeeded in the final option ranking. The students' average order of the final option-ranking close to the preferred ranking. The strategy used most frequently by the students for initial option-ranking was the conjunctive and the additive strategies. The students read less information after the second option-ranking. The average student read 60% of the total information provided in the simulation. It was found that the subjects read most frequently on the information about the disadvantages of the options. In addition, the subjects read most the cards relating to composting and waste-to-energy. The students are most concerned with the environmental aspects of the options for the solid waste management.

S2.03

LEARNING CLIMATE, SATISFACTION AND GRADES IN CHEMISTRY IN GERMAN SCHOOLS
Olaf Koeller and Claus Bolte, Institute for Science Education, Kiel

German didactic research often deals with special methodological aspects of science teaching and their influence on achievement. Most of the studies don't take into account other significant variables, particularly learning climate. This is surprising, since a positive learning climate corresponds to higher student satisfaction and achievement. The aim of our current study is to introduce different learning climate variables into chemistry instruction as potential predictors of student satisfaction and achievement (indicated by grades) in chemistry instruction. We built a hypothetical model concerning the relationships among five learning climate indicators (profile of requirements, subject relevance, opportunities to participate, class cooperation and students' willingness to participate), and the expected student satisfaction and achievement. To test our model we administered a special questionnaire (the KLCQ, Bolte, 1993) to two sample groups from different types of high schools. The first sample consisted of 325 students from a selective high school, the second one consisted of 264 students from a normal high school. Path analyses show that in both cases the five learning climate variables are significant determinants both of students' satisfaction with chemistry instruction and of achievement (grades).

S2.03

STUDENT AUTONOMY AND PREORDAINED SCIENCE: THE NATURE OF THE LABORATORY TASK IN PHYSICS CLASSROOMS.
Timothy P. Olsen and Peter W. Hewson, University of Wisconsin-Madison

Four experienced physics teachers were observed and videotaped, interviewed about classroom events, and interviewed about researchers' tentative analyses during two 'challenging' topics. By examining classroom activities and discourse, instructional materials, content, and laboratory equipment, Project DISTIL provides a detailed portrayal of cases showing how high school science teachers define tasks and construct activities. This paper focuses on laboratory activities, where we found that students were given decision-making responsibilities of various kinds and to different degrees. The teachers played diverse and unique roles in communicating expectations and reinforcing students' work to structure desired student outcomes. Intended outcomes resonated with teachers' beliefs about the nature of science and about student learning. Our results address the following questions:

1. What are students expected to accomplish during lab?
2. What and who defines what gets done in the lab?

S2.04

ANALYSIS OF CROSS-AGE TEACHING IN SCIENCE: EFFECTS ON ELEMENTARY STUDENTS' ATTITUDES TOWARD SCIENCE
Mary T. Stein, Wayne State University

The purpose of this study was to examine the effect of cross-age teaching in science on the attitudes toward science of elementary students. The 470 fourth and fifth grade students, in three different school districts, received hands-on, activity-based science lessons each week which supplemented their regular science instructional program. The treatment group consisted of 275 of these students who were taught by high school juniors and seniors. The remaining students were taught by their regular classroom teachers. Attitude towards science was measured by a thirty-six item Likert Scale instrument designed by the author of the study. Pre and post scores were analyzed for any significant change. Results indicated that both groups (treatment and control) demonstrated significant gains in attitude towards science. However, no significant differences were found between the treatment and control groups in attitude towards science gains. Statistical analyses conducted supported the reliability and validity of the attitude towards science instrument developed for this study and yielded important information concerning the attitudinal effects of cross-age teaching on younger students.

S2.04

TEACHING COMPLEX SUBJECT MATTER IN SCIENCE: INSIGHTS FROM AN ANALYSIS OF PEDAGOGICAL CONTENT KNOWLEDGE
Shirley Magnusson, The University of Michigan
Joseph Krajcik, The University of Michigan
Hilda Borko, The University of Colorado

This paper describes the analysis of teacher pedagogical content knowledge for the topic of heat energy and temperature. Results provide information about areas in which teacher pedagogical content knowledge may be weak, and identifies knowledge that can help teachers be more effective at facilitating the development of scientific knowledge. We would argue that such information is useful to teacher educators for planning and implementing preservice as well as inservice instruction (Krajcik & Borko, 1991). A limitation of this study was that teacher PCK was not assessed in the context of all the phases of teaching: planning, interactive teaching, and reflection. Teacher reports of their instruction (Magnusson, 1991), for example, indicate that the knowledge evident in their interview was not necessarily employed in their teaching. This discrepancy indicates the complexity of how teacher knowledge translates into instructional action, and further points to the need for investigation of teacher knowledge and decision-making in all phases of teaching.

S2.05

USE OF HISTORICAL VIGNETTES IN A NONSCIENCE MAJORS' COURSE: DOES IT AFFECT STUDENTS' UNDERSTANDING OF THE NATURE OF SCIENCE
Linda E. Roach, Northwestern State University and
Ronald G. Good, Louisiana State University

Interactive historical vignettes were utilized in a quantitative and qualitative investigation in a university level, introductory nonscience majors course to determine if inclusion of the history of science in such a course would induce conceptual change about the nature of science without sacrificing student understanding of the physical science content. Interactive nature-of-science historical vignettes employ the interrupted story form to generate student discussion about the nature of science. The Nature of Science Questionnaire was developed. Based on a model of the nature of science drawn from science education research literature, it was utilized to quantitatively determine if the experimental technique was useful. Qualitative research, in the form of content analysis of journals and transcripts of interviews, was performed to determine what conceptions students held before and after treatment. Students who participated in the nature-of-science vignettes demonstrated statistically significant gains in an understanding of the nature of science with no losses in understanding of physical science topics. Students who did not participate in the interactive historical vignettes did not show similar gains. Content analysis of journals and interview transcripts provide evidence that qualitative research should accompany questionnaires when investigating student understanding of the nature of science.

S2.05

SCIENTIFIC RESEARCH AND ON-COMING VEHICLES: CAN RADICAL CONSTRUCTIVISTS EMBRACE ONE AND DODGE THE OTHER?

John R. Staver, Kansas State University

The author's purpose in this paper is to respond to two questions raised by Roth and Lawson in the September, 1993 issue of the Journal of Research in Science Teaching. Question #1: Would a radical constructivist step out of the path of an approaching vehicle? Question #2: In the conduct of inquiry, would a radical constructivist employ a controlled experiment, test a hypothesis, and quantitatively analyze the data? The author answers each question affirmatively, using selected work of Heinz von Foerster, Ernst von Glasersfeld, and others in developing the answers. Issues central to the development include the nature of knowledge, the concept of fit versus match, and the notion that inquiry is driven by questions, with methods as subordinate to questions.

S2.06

PARTNERS IN RESEARCH: TEACHERS, EDUCATION FOUNDATION CURRICULUM DEVELOPERS, AND UNIVERSITY RESEARCHERS IDENTIFYING STUDENT OUTCOMES RELATED TO INTEGRATED SCIENCE AND MATHEMATICS EDUCATION

Donna F. Berlin and Judith A. Hillen, The Ohio State University and AIMS Education Foundation, Fresno Pacific College

A three-phase research project has been established between The National Center for Science Teaching and Learning (NCSTL) and the AIMS Education Foundation. The goal of Phase I is to identify student outcomes as perceived by classroom teachers to be related to participation in a hands-on, integrated mathematics/science program called AIMS, Activities Integrating Math and Science. Data collection procedures involved 45 elementary school teachers and approximately 1300 students at eight research sites in six states. Teachers identified 423 cognitive, 234 affective, and 188 social outcomes. An unexpected teacher outcome also emerged. Teacher involvement in the research project greatly contributed to their own sense of professionalism. Phase II will develop prototypic assessment items for selected high priority student cognitive, affective, and social outcomes. These items will be piloted during Phase III. The ultimate objective of this three-phase project is to develop an assessment package related to integrated school mathematics and science.

S2.05

THE IMPACT OF TEACHERS' CONCEPTIONS OF THE NATURE OF SCIENCE ON THE PLANNED IMPLEMENTATION OF CURRICULUM.

Moreen K. Travis, University of Cincinnati

This study explored the effect of teachers' conceptions of the nature of science on the planned implementation of a mandated curriculum. Ethnographic interviews and document analysis were used to determine the relative influence of teachers' conceptions of science on planned implementation compared to those expressed in the curriculum itself. Analysis of teachers' conceptions, teachers' planned implementation and the mandated curriculum indicated that teachers' conceptions of the nature of science play a greater role in planned implementation than do those of the curriculum being implemented. These results led to the formation of the hypotheses that (a) teachers' conceptions of the nature of science play a definitive role in determining implementation of science curriculum, and (b) teachers will tend to faithfully implement science curriculum that they perceive to reflect their own view of the nature of science.

S2.06

COLLABORATIVE RELATIONSHIPS IN SCIENCE EDUCATION REFORM INITIATIVES: INSIGHTS FROM NATIONAL CENTER FOR SCIENCE TEACHING AND LEARNING STUDIES

Robert Donmoyer, National Center for Science Teaching and Learning

This paper presents insights about collaborative relationships gleaned from a research program focused on a diverse array of science education reform initiatives. The goal of this particular program has been two fold: (1) to develop a storehouse of context-rich case material which will provide a deep understanding of the complexities associated with educational reform in general and the reform of science education in particular and (2) to use this diverse case material to begin to build a grounded theory about science education reform. Given the research program's focus on reform, it is not surprising that collaborative relationships have emerged as significant variables, since most contemporary reform efforts at the very least, pay lip service to the importance of collaboration. This paper moves the discussion beyond the level of rhetoric by presenting data—largely qualitative in nature—about a number of quite diverse science education reform initiatives. These data offer insight about the costs as well as the benefits of collaboration. They also suggest conditions required to make collaboration work.

S2.06

SCIENCE TEACHING PARTNERSHIP PROJECT: ENHANCING THE PROFESSIONAL STATUS OF TEACHERS

Michael H. Klapper - The Ohio State University, Columbus and Phillip Heath - The Ohio State University, Lima: the National Center for Science Teaching and Learning

The Science Teaching Partnership Project establishes partnerships between teachers and college/university faculty. Teachers are chosen for this Project competitively on the basis of proposals they submit for the development of a one to two month science teaching module for use in their own classroom. In addition to the partnerships arranged with Ohio State University faculty and researchers, the teachers receive $1000 for their discretionary use; their school receives an additional $250 for use in science education within the building. Based on the small sample to date, we conclude initially that middle/junior-high school teachers can carry out their own curricular innovations without a prior workshop or an administratively structured school environment. This in spite of potential barriers within the schools and extensive extra work by the teachers who receive no personal financial or educational compensation. The analysis of our results to date also indicates that this program has had an immediate, beneficial professional impact on the majority of the teachers involved. We shall present the reasons for our conclusions and further description of the program and of the teachers efforts.

S2.07

Assessing Students' Abilities to Construct and Interpret Graphs:Disparities Between The Results of Free-response and Empirically-derived, Multiple-choice Instruments

Craig A. Berg, The University of Wisconsin-Milwaukee

Prior research that examined graphing abilities suggests that clinical interviews and free-response instruments produce very different results than multiple-choice instruments. The purpose of this research is to compare subjects' responses on a free-response instrument to subjects' responses on an empirically-derived multiple choice instrument. The five to eight choices on the multiple-choice instrument came from graphs drawn by 770 subjects from prior research on graphing (Berg, 1989; 1992a; & 1992b). Chi-square statistical analysis of the 734 seventh through twelveth grade subjects showed significantly different responses on the empirically-derived multiple-choice version compared to the free-response version regarding both the number of correct responses and the number of "pictures of the event". Subjects using the multiple-choice version chose two to three times more "pictures of the event". Regarding the questions used for this research, multiple-choice instruments are not a valid indicator of graphing abilities. Graphing "misconceptions" such as "picture of the event" may be more of an affect of the instrument than a widespread misconception.

S2.06

PARTNERS IN RESEARCH: TEACHERS AND UNIVERSITY RESEARCHERS COLLABORATING IN CLASSROOM-BASED RESEARCH

Arthur L. White and Donna F. Berlin, The Ohio State University

The Academic Challenge Program (ACP) has been implemented for five years as a collaboration between inservice teachers and The Ohio State University at Newark. The focus of this program is action research designed to facilitate the collaborative, systematic development of research-based, innovative educational practices. Eighty-seven classroom teachers completed action research projects involving the development, implementation, evaluation (using quantitative and/or qualitative research methods), and dissemination of innovative educational methods and materials. Data analysis indicates that the attitude and perception mean scores increased substantially from pre-test to post-test as measured by semantic differentials related to both educational innovations and educational research. Three of the four years resulted in significant positive changes in attitudes and perceptions toward educational research. For the year in which no change was found, the entry level attitude and perception scores were already at a high level. In summary, the quantitative data analysis indicates that the participants made significant growth. Follow-up qualitative data indicates continued professional growth. The teacher participants have made presentations, published, assumed leadership roles, been awarded grants, and completed Master's Programs.

S2.07

THE MISCONCEPTIONS ON ACIDS AND BASES HELD BY 5TH AND 6TH GRADERS IN TAIWAN

Huang, Wanchu, Taipei Municipal Teachers College, Taiwan

The main purpose of this study was to investigate the misconceptions on acid and base using open-ended paper-pencil questionnaires and interviews. The study found that: 1. the children understood the concepts of acids and bases from daily foods better, but most children only knew the acidity and basicity by taste, smell or touch. 2. Most of the children thought that an acid and base mixture was neutral; they did not have the quantitative concept of neutralization. 3. Most children did not know why acidic substances are acidic; only a few children thought that there was an acidic element in the acidic substance. 4. The children answered less base question items than acid ones; they had less conceptions of basicity that conceptions of acidity. 5. Most children thought the differences between strong acid and weak acid were: (1) the degree of harm to people and objects. (2) the concentration or amount of water added. 6. Many children thought that nothing remained when the mixture of acid and base solution was entirely evaporated.

S2.07

USING PERFORMANCE ASSESSMENT TO ELICIT COGNITIVE PROCESSES
Richard R Sudweeks & Samuel Clay, Brigham Young University

The purpose of this study was to describe the cognitive processes elicited by a performance assessment, and to contrast the thinking processes used by knowledgeable versus less knowledgeable students. Both "concurrent verbalization" and "retrospective verbalization" procedures were used to collect evidence of the thinking processes used by subjects while performing tasks excerpted from a performance test. Subjects were videotaped to record their overt behaviors as well as their speech. Subjects also completed concept classification and card sorting tasks. The responses of eight undergraduate physics majors were compared with the responses of eight elementary education majors enrolled in a science methods class. The groups differed very little in their ability to identify the "directly related" concepts in the classification task, but the physics students were more adept in identifying unrelated concepts. The physics students were better able to describe the interrelatedness of the concepts and were more articulate in formulating meaningful explanations of the sinking/floating behavior. They were also better at explaining what they had observed in terms of general principles.

S2.09

IDENTIFICATION OF INFORMED, PARTIALLY INFORMED, MISINFORMED AND UNINFORMED CONCEPTUAL SCIENCE KNOWLEDGE OF RURAL IDAHO ELEMENTARY TEACHERS
Sandra A. Melchert, University of South Dakota

The purpose of this study was to determine the level of science knowledge of rural Idaho teachers using an information referenced assessment and to compare and contrast the confidence and reliability of that science knowledge by several demographic variables: grade level, years of experience, size of district, and state in which initial certification was received. Information referenced assessments were designed for the Biological, Earth and Physical Sciences. Response options were determined from K-6 (n = 211) student responses to open ended questions. All test questions were cross-referenced to state curriculum objectives. The assessments were administered to K-8 (n = 84) educators from eight rural Idaho school districts from the Idaho TRAILS grant. Three 50 item assessments were designed for the study. Results indicated that elementary teachers held many of the same misinformed concepts as their students. Statistical analyses conducted on each of the demographic variables supported the aim of the study. Regardless of the demographic variable investigated, two observable trends were noted: 1) the greatest percentage of informed responses were identified in the Biological Sciences and the least percentage was in the Physical Sciences; 2) the greatest percentage of uninformed responses were identified in the Physical Sciences and the least percentage was in the Biological Sciences.

S2.09

SCIENCE-TEACHERS AS UNCRITICAL CONSUMERS OF INVALID CONCLUSIONS: LACK OF COMPETENCE OR JUST POOR PERFORMANCE?
Ehud Jungwirth, The Hebrew University, Jerusalem

Science-curricula -- worldwide -- stress the importance of developing intellectual skills, in particular critical, analytical thinking. Such "analytical enquiry-skills" are the backbone of laboratory-centered curricula, in particular in biology. It has been shown that -- in spite of curricular expectations -- such skills are rarely sufficiently stressed by teachers. Studies in several countries have shown that many teachers do not possess them themselves. This paper presents data from Germany, U.S.A., South Africa and Israel whose common denominator is, that the majority of science (student-) teachers tested failed to attend spontaneously to the logical structure of given simple situations i.e. they accepted logical fallacies contained in conclusions invalid because of faulty methodology. Many even failed to attend critically to the logical structure when explicitly directed to evaluate the validity of the given conclusions. The tests -- open and closed formats -- related to improper a posteriori causal attributions (post-hoc thinking and improper sampling procedures) as well as tautological "explanations". Overall -- about one third applied their competence spontaneously -- one third only after prompting i.e. poor performance -- the rest clearly displayed their incompetence in this domain.

S2.09

THE CURRENCY OF TEACHERS' SCIENTIFIC KNOWLEDGE: TEACHER DEVELOPMENT CONFRONTING AN EMERGING PARADOX.
Lesley H. Parker, John W. Wallace and Helen Wildy, Curtin University of Technology

This research addresses an emerging paradox in teacher education. On the one hand it is recognized that the best teachers are those who understand their subject matter well. On the other hand, as knowledge in all areas increases exponentially, there is less and less likelihood that teachers' subject matter knowledge will be current. The purpose of this research was to analyse a model of professional development which addressed this paradox. The research focused on science teachers who participated in a 'training-of-trainers' professional development project. Data were gathered by means of questionnaires, interviews and classroom observation. Analysis of the data indicated that resolution of a content-pedagogy tension was fundamental to the success of the project, and that although the 30 'key' teachers who received concentrated, direct exposure to new science content benefitted from the project in many ways, the benefits for the bulk of teachers were dependent upon translation of the new science content into resources which were immediately useful in the classroom.

S2.10

PERSONAL REFLECTION ON LEARNING SCIENCE THROUGH GUIDED INQUIRY

Sandra J. Finley and Frank E. Crawley
Science Education Center
University of Texas at Austin

A longtime community college biology instructor, Sandra was enrolled in a guided-inquiry physical science course. This study is a self-reflective inquiry into the process of becoming an active learner of science. Using a qualitative design, her own learning during her participation as a student in this physical science course was analyzed. The objective of the study was to understand what it means to actively construct knowledge from the point-of-view of the learner. The data source was her double-entry journal. The theoretical basis for the study is the constructivist approach utilizing writing-to-learn and social construction of meaning. The findings are summarized as six assertions. From these assertions we concluded that there is initial discomfort experienced in the shift from a positivist to constructivist learning environment, but the change resulted in more meaningful learning and increased ownership of the outcomes.

S2.10

EDUCATIONAL REFORM: A NEW CONTEXT

Iain Hendren and Dr Nancy Davis, Florida State University

This study is interpretive research analyzing reform in undergraduate education in science for prospective teachers in early childhood education and elementary education. Questions of epistemological fit between the students views of learning, teaching, and science and the teachers were studied. The views of Gregory Bateson were used to provide a context in which to view the classroom.

S2.10

THE PROCESS OF CULTURAL CHANGE IN FACULTY FROM ARTS & SCIENCES.

Penny J. Gilmer, Hedy Moscovici, and Iair Hendren, Florida State University

The study is interpretative research anaylzing changes in science faculty who are teaching new interdisciplinary science courses for prospective elementary teachers. We want to learn how Arts and Sciences faculty change as they learn how to meet the needs of prospective teachers in science classes. This research has involved cooperation and communication between the faculty and graduate students in both the College of Education and of Arts and Sciences. Understanding the dynamics in interdepartmental cooperation together with changes in beliefs in science faculty will lead to better science preparation of prospective elementary teachers.

S2.11

AN ETHNOGRAPHIC ANALYSIS OF VARIABLES RELATED TO AN ELEMENTARY SCHOOL SCIENCE TEACHER SUCCESS

Tien-Ying Lee, National Taiwan Normal University

The purpose of the study is to understand an elementary school teacher's science knowledge and her science teaching. An interpretive research method is adopted A literature major teacher with four years teaching experience was selected, observed and video-taped. The school's administrators, teacher, and her students were interviewed. The findings of the study indicated that there is a consistency between a teacher's beliefs in science and her science teaching. When a teacher feels uncomfortable with her science knowledge, she will have difficulties in putting her beliefs into practice. Help from the experienced teachers and administrators are important for a teacher's professional development.

S2.11

IMPLEMENTING THE ROLE OF FACILITATOR: A CASE STUDY IN ELEMENTARY SCIENCE.
Mark D. Guy, The University of North Dakota

The purpose of the study was to describe, analyze, and interpret how an experienced elementary teacher gave meaning to a self-determined endeavor to become more of a facilitator during science instruction. The intent of the study was to document the teacher's perceptions of elements or events that she perceived to make a difference while implementing more student-centered instruction. Qualitative case study methodology was selected as a means to inquire into a teacher's perspective on a role change process. Data collection, which consisted primarily of interviews and field notes, occurred for 15 months during one and a half academic years. The findings revealed that the teacher found it difficult to sustain her desired role change throughout the study. The teacher perceived numerous personal and contextual elements that made a difference for her during the role change process. Some elements were perceived as constraints, others as aids, still others were perceived to both constrain and aid her role change endeavor. During the change process some of the teacher's perceptions changed while others remained more stable.

S2.11

CHANGING THE EXISTING PRACTICE: A PRESERVICE TEACHER'S STORY

Anita Roychoudhury
Miami University
Hamilton, Ohio

Within a classroom community the teacher has a major role as she is the decision maker about what will be ultimately sanctioned for teaching, learning, and socialization. Thus what is taught, how it is taught, and the type of learning culture that develops through assignments and assessments is shaped by the teacher. Once certain frameworks for the interpretation of teaching-learning processes have been developed a drastic change may engender an imbalance in the system. I will describe an action research project embedded in the non-traditional science teaching by a student-teacher in a fifth grade classroom, whereby she learned to develop a congruence among various facets of classroom processes. The implications of the reflective practice at the core of this study will also be discussed.

S4.01

DEVELOPMENT AND TESTING OF A MIDDLE SCHOOL SCIENCE VISUAL LITERACY SURVEY
Janet L. Bohren, University of Cincinnati

Thirty teachers from a large urban district and five small rural/suburban districts have worked for two years to develop effective multimedia lessons focusing on the use of student visual learning skills to improve science achievement. The purpose of this study was to develop and test a survey that would enable us to gain insight into how students perceived the use of images in science instruction to be useful to them for learning science. A 29-item survey was administered to 600 urban students. This was refined to 20 questions and administered to about 1000 students in both the urban and rural/suburban settings. Results indicated 14% of the students strongly preferred working with images on tests. On a set of questions asking how they learned science best, by seeing/looking, reading/writing, or doing, an average of 12% strongly agreed with the seeing/looking and 15% with reading/writing statements. Implications for use of multimedia technology in the classroom for these strongly visually and verbally oriented learners is discussed.

S4.01

Investigating the nature of formal reasoning in Chemistry:
Testing Lawson's Multiple Hypothesis Theory
Obed Norman, University of Georgia.

Piagetian measures of formal reasoning have consistently shown appreciable correlation with achievements in science and other areas. Lawson (1992) posits the multiple hypothesis theory as the core of an empirically-based view regarding the essence of scientific reasoning. According to this theory the essence of scientific reasoning is 'the ability to initiate reasoning with more than one antecedent condition' (p. 965). This study is aimed at testing this theory by analyzing the responses of high school students and chemistry logic tasks. After determining their Piagetian developmental level, the students were administerd the logic tasks. On the general logic tasks the responses of the high school students followed the same pattern as those of the college students in the Lawson (1992) study. The percentage of students using the conditional logic pattern suggest that there were more conditional responses on those tasks where it was more feasible to conceive of alternate antecedent conditions. The findings in this study are similar to the findings of the Lawson study and provides further empirical evidence that reasoning cannot be viewed as a decontextualised construct.

S4.01

INFLUENCE OF ENGAGEMENT IN INDIGENOUS TECHNOLOGY ACTIVITIES AS PROJECT WORK ON THE ACQUISITION OF SELECTED PROCESS SKILLS IN CHEMISTRY

Ngozi Osuji, University of Nigeria, Nsukka and
Peter Okebukola, Lagos State University, Lagos, NIGERIA

This study sought answers to two research questions which focused on the potency of project work based on the use of indigenous technology on the development of selected process skills by chemistry students. One hundred and seven senior secondary class two students (eleventh grade equivalent) were involved in the study in one experimental and a control group. Data on process skills were collected using the Test of Science Process Skills (TSPS). Both groups were pre and posttested using TSPS. In between testing sessions, the experimental group worked in mixed-ability, mixed-sex project teams using indigenous technology such as local method of soap making to tackle group tasks. A 3-way ancova showed significant main effects at alpha level .05 and better for observation, classification, manipulation, interpretation and experimentation skills but not for measurement in favor of the experimental group and the high ability students. Sex did not emerge as a significant factor. The findings are discussed for improving process skill development of chemistry students and for the delivery of good quality science education in developing countries.

S4.01

PRAGMATIC SCHEMAS AND CONDITIONAL REASONING IN TWELFTH-GRADE STUDENTS

Valanides Nicolaos, University of Cyprus

The pattern of reasoning required to solve the Wason's four-card problem (selection problem) generated interest because of its relation to scientific reasoning and to aspects of Piaget's theory. Content and context effects were however found to enhance or inhibit performance on selection problems and the Piagetian approach to this topic has more recently been challenged by findings that are more readily explained in terms of the concept of pragmatic reasoning schemas. The pragmatic reasoning hypothesis was contrasted with Piaget's theory using twelfth-grade students who were grouped into stages of cognitive development based on their performance on a standard test of logical thinking. Nineteen subjects from each stage of cognitive development were randomly assigned to no training, formal, or pragmatic training. The subjects were posttested using selection problems involving arbitrary and permission-like (thematic or abstract) conditional rules. Performance was significantly better for subjects at higher stages of cognitive development and for permission problems. The main effect related to training was not significant, but there was an interaction effect between training and stage of development. The interaction effects between either training stage or stage of development and type of problem were also significant. Implications of results are forwarded and discussed.

S4.01

MAKING INFERENCES AND EVALUATING EVIDENCE IN PRACTICAL INVESTIGATIONS.

Isobel J. Robertson, University of Strathclyde, Glasgow, Scotland.

1000 pupils aged 14 - 16 years provided data over a two year period for a study of the learning and teaching of skills of inference and evaluation of evidence. It covered the first two years of a new Scottish biology course with a stated aim to emphasise science process skills. Published materials devised by the speaker as part of the Techniques for the Assessment of Practical Skills in science (TAPS) research team (Bryce, McCall, MacGregor, Robertson and Weston, 1988; 1991) were among the validated assessment materials used. Pupils' difficulties in drawing conclusions, selecting appropriate hypotheses, and making deductions from or modifications to hypotheses in structured investigations were identified and categorised and the relationship of difficulties to content and context were explored. Evidence that significant percentages of pupils made theory-based as opposed to evidence based responses was adduced. Ability to formulate and test hypotheses and evaluate findings of individual, self-directed, open-ended practical investigations was also assessed. Strategies which were or might be adopted by teachers for the development of science process skills were evaluated.

S4.02

ELECTRONIC DIALOGUE AND SCIENCE KNOWLEDGE INTEGRATION

Nancy B. Songer, University of Colorado, Boulder; William Barowy and Denis Newman, Bolt Beranek and Newman Inc., Barry Saferstein, University of California, San Diego;Marcia Linn, University of California, Berkeley; and William Kyle, Purdue University

Featuring an interactive technologically-rich format, this symposium contrasts three projects that employ electronic communication strategies in unique ways to foster scientific knowledge integration. To clarify differences and identify commonalties each project will address three main themes. First, the conceptual frameworks guiding each of these projects will be contrasted. All three projects are committed to actively engaging students in analyzing and explaining scientific phenomenon and in conceptualizing, revising, and reconceptualizing scientific events. Second, the forms of electronic communication that characterize student activities will be contrasted. Third, each of the projects will examine how students integrate. Each group will illustrate the kinds of interactions that students carry out using electronic communication and characterize the course of knowledge development that this form of communication supports. The relative advantages of synchronous and asynchronous electronic communication, as well as the special contributions of communication within a school site and between school sites will be considered. In addition, communication between students and those viewed as authorities including teachers and text materials provided by experts, will be considered. Finally, each participant in this symposium will comment on how the conceptual framework, electronic communication environment, and course of student knowledge integration drive project activities.

S4.03

THE EFFECT OF SCHOOL AND DEPARTMENTAL VARIABLES ON THE IMPLEMENTATION OF A SCIENCE TEACHING INNOVATION: COMMUNICATION.

Philip Adey King's College, London University

A total of 110 teachers from 13 schools participated in a two year staff development program which introduced the theory and methods of Cognitive Acceleration through Science Education (CASE). Interviews with a 44% sample of these teachers provided a measure of the extent to which they were using or adapting the CASE innovation. Data obtained from a questionnaire yielded measures of inter alia, teacher' sense of ownership of the project and the extent to which they communicated with one another about the project within the school. A very strong relationship was found between schools' levels of use of the innovation, and communication measures. Implications are drawn concerning factors which are influential in making staff development work.

S4.03

TURNING TO THE FACE OF SCIENCE THAT DOES NOT YET KNOW: A PERSONAL CONSTRUCT ANALYSIS OF CHANGES IN STUDENT TEACHER THINKING ABOUT THE NATURE OF SCIENCE FOLLOWING WORK IN INDEPENDENT INVESTIGATIONS

Bonnie L. Shapiro, The University of Calgary Calgary, Alberta

The last half century one of the most important goals in science education has been the development of students' understanding of the nature of science. Despite this, research continues to show that, for a variety of reasons, many students and teachers hold views about the nature of knowledge acquisition which are absolutist or build on a position of naive realism. This paper presents an approach to the study of change in student teachers' ideas about the nature of knowledge acquisition in science. During a pre-service course in curriculum and instruction in elementary science, students were assigned the task of designing independent investigations. Ideas about the nature of knowledge acquisition were documented prior to, during, and following involvement in the assignment. Students were shown the documented changes which occurred in their personal ideas. In reflective interviews they were invited to comment on their participation in the investigations and to describe specific features of the experience which contributed to changes in their ideas about the conduct of investigations in science.

S4.03

BARRIERS TO TEACHERS' RECONSTRUCTION OF THEIR ASSESSMENT PRACTICE

Léonie J. Rennie and Lesley H. Parker, Curtin University of Technology

This study monitored teachers' reconstruction of their assessment practice in association with a curriculum reform aiming to provide a more contextually-based approach to the teaching and learning of physics in the 11th and 12th grades in Western Australia. Data were collected in three stages from representative samples of 20 teachers by examining teachers' "marks' books" and using surveys and interviews teachers' experiences and their decision making in relation to assessment. Teachers' assessment practice during the 1992 academic year showed they gave 80% weighting to test and examination performance, and the balance to assignments and laboratory work. There was heavy emphasis on calculations. With the new curriculum, however, there was a shift in emphasis, to more written and project work with fewer calculations. Actual change in practice was associated with teachers' degree of commitment to the goals of the new curriculum, and their desire to be consistent with the assessment tasks on the "high-stakes" externally administered Tertiary Entrance Examination.

S4.05

THE CONCEPTUAL ECOLOGY OF STUDENTS' SCIENTIFIC AND RELIGIOUS BELIEFS

Todd Alexander and Wolff-Michael Roth, Simon Fraser University

The present case study of students' scientific and religious beliefs was situated in the context of a two-year physics program in which we, the authors, were teacher and student respectively. We engaged in this study for two major reasons. First, we believed that it would help us in understanding the complex ecology of high school students' beliefs and how to deal with their conflicting scientific and religious dimensions of these beliefs. Second, in the process of coming to understand the data from various data sources, we developed the construct of interpretive repertoires which allowed us to interpret the variations within and across accounts of individuals' beliefs. This construct allowed us to explain not only students belief systems but also those of scientists and and evolutionists. We situated our inquiry in an interdisciplinary matrix by drawing on resources beyond the area of science education, including the literature in science, philosophy, theology, sociology, communications theory, social psychology, political science, and original court decisions.

S4.05

WAYS OF KNOWING AMONG COLLEGE NONSCIENCE MAJORS: A WORLD-VIEW INVESTIGATION.

Isaac Lassiter, Hanover College

This study determined (a) presuppositional ways of knowing, (b) the compatibility of these ways with scientific interpretations of phenomena, and (c) sociocultural influences on the students' knowing. This research is based on Cobern's synthesis of (a) Kearney's world-view model, (b) Arendt's distinction between thinking and knowing, and (c) Solomon's theory of social construction of school science. The paradigm is modified naturalistic, interpretive, and qualitative, consistent with Lincoln and Guba's guidelines and Cobern's synthesized concept of contextual constructivism. Interview data were processed using Glaser and Strauss' constant comparative method of inductive analysis and confirmation rules developed by the researcher. Selected results were displayed in graphic form and confirmed with the students. The most common ways of knowing are authority, facts/proof, prior knowledge, experience, reasonableness, testing, evidence, trust, and understanding; and these involve relationships of contradiction, complementarity, and integration. The students' attributions of causality comprise two basic categories: effective power and conscious design or purpose. These ways of knowing in general are only moderately compatible with one common understanding of the nature of science. The strongest sociocultural influences are parents, associates, teachers, and background.

S4.05

Hearts and Minds in the Science Classroom: The Education of a Confirmed Evolutionist

David F. Jackson, Elizabeth C. Doster, Teresa Wood. University of Georgia, and Lee Meadows, University of Alabama at Birmingham

This study examines the intellectual and emotional viewpoints of scientists, science teachers, and prospective science teachers in the southern United States who have managed, in various ways, to reconcile their conservative or fundamentalist Christian religious beliefs with the idea of biological evolution. We take the theoretical position that the gap between the philosophical and experiential backgrounds of superficially similar people can sometimes be so pronounced on a regional or local basis as to constitute a multicultural issue in education. Through commentary on transcripts of discussions and interviews, a heuristic inquiry process is traced from the point of view of a science educator with a Northern secular humanist background who comes to better understand and appreciate a major aspect of Southern religious culture which has a major bearing on science education in the region. We conclude that only at their own peril may science teachers and educators make decisions based on stereotypes and prejudices, ignore the threats they may pose to students' self-esteem, or deny the *de facto* connection of some scientific ideas to the morality, attitudes, and values of students.

S4.06

STUDENTS FACILITATING CONCEPTUAL CHANGE/ THE USE OF FOCUS GROUPS IN BIOLOGY CURRICULUM DEVELOPMENT.

Eleanor D. Abrams and James H. Wandersee, Louisiana State University

Research has shown that most students graduate from high school without a fundamental understanding of photosynthesis or the importance of photosynthetic organisms in food webs. In response, we decided to develop a video about photosynthesis based on the conceptual change theory of learning, which focuses on the learner. Traditionally students are not involved in any phase of curriculum development, however, we wanted to include the use of student focus groups into the video script development. We thought students could suggest the most effective set of examples and nonexamples to bridge the gap between what they knew to the new knowledge about photosynthesis. The original script, reviewed by two botany specialists and two high school biology teachers, included both examples and nonexamples, with some of the nonexamples addressing common alternative conceptions. Two student focus groups met with a moderator for one week to review the script. Their script annotations and the resulting audio-taped transcriptions provided a view of how students think and talk about photosynthesis. Implications of using students focus groups in education settings are discussed.

S4.06

EFFECTS OF A NEW CONSTRUCTIVIST-BASED MIDDLE SCHOOL SCIENCE CURRICULUM ON STUDENT ATTITUDES TOWARD SCIENCE

Randall K. Backe, Biological Sciences Curriculum Study, and Emmett L. Wright, Kansas State University

The purpose of this study was to investigate whether a new constructivist-based S/T/S middle school curriculum could influence change in students' attitudes toward science. The use of a field-test edition of the new curriculum served as the intervention for the three treatment group schools during one academic year. The three control group schools employed more traditional curricula. Results from the quantitative portion of the study suggested that both the treatment and control groups experienced a general decline in attitudes toward science during the school year. Despite this general decline, students in the treatment group found the new curriculum more fun as the year progressed and they also felt better equipped than the control group to do well in college science. Findings from the qualitative portion of the study, however, suggested that students and teachers preferred certain elements of the new curriculum, such as cooperative group learning and the activity-oriented approaches. The qualitative findings also suggested that the process of field-testing itself may have been a confounding factor which obscured the positive potential of the new curriculum.

S4.06

CURRICULUM, TEACHING, AND STUDENTS' LEARNING: OBSERVATIONS OF THIRD-GRADE SCIENCE CLASSES.

Chao-Ti Hsiung, National Taipei Teachers College, Taiwan

The purpose of this study was to investigate the relationships among national science curriculum materials of the Republic of China, two elementary teachers' teaching, and third-grade students' learning. The units being examined dealt with "plants" and "fishes, birds, and mammals." The study was based on Habermas' emancipatory knowledge-constitutive interest theory and Vygotsky's concept of meditation in teaching theory. The intent was to investigate the social context in an elementary science classroom. The study was held at an elementary school in Taipei City from September, 1991 to March, 1992. The participants of the study included three observers from a Teachers College, two elementary teachers (Ms. Wang and Ms. Lin), and an intact class of forty-seven third-grade students. The data sources of the present study included: fieldnotes, videotape transcripts of classroom observations; teacher and student interviews; and curriculum materials such as the teacher's guide, students' workbooks and worksheets. Results showed that the power of the national science materials (teacher's guide) affected their decision and implementation of science teaching. Moreover, the controlling classroom learned by Ms. Wang and Ms. Lin was described by the excepted data. The comparison of the two teaching styles illustrated how teachers mediated students to learn science concepts. The results of the study implicate that it is important for science educators to consider the relationship among curriculum teaching, and learning based on two perspectives: Habermas' emancipatory interest and Vygotsky's concept of meditation in teaching.

S4.06

EVALUATING INSTRUCTION IN TWO DIFFERENT INTRODUCTORY CHEMISTRY COURSES: WHAT WE KNOW AND WHAT WE DON'T.

Brian P. Coppola and Oksana Malanchuk, The University of Michigan

In 1989, The University of Michigan implemented a comprehensive change in its undergraduate chemistry curriculum. We have revisited the fundamental questions of content, method, and instructional goals in the context of an audience with such diverse needs as first-year college students bring to the 500-seat classroom. The result of this thinking begins with a new sequence called *Structure and Reactivity*. Rather than relying on accumulating factual content in order to achieve conceptual understanding, instruction centers on the "how" and the "why" of scientific inquiry, along with explicit instruction on how we transform information into meaning. In this session, we will present three discrete aspects of this new program as a framework for curriculum design. First, we will review the underlying philosophical context for these courses. Second, we will look at specific methods that support metacurricular, or imbedded "learning how to learn" instruction. Third, we will demonstrate how collaborations with education and cognitive scientists help inform us about curricular design.

S4.07

PORTFOLIO ASSESSMENT IN A CHEMISTRY CLASSROOM

Susan M. Butler, Rutherford High School

In the course of this study, one-hundred high school chemistry students kept a portfolio of work done in the chemistry class. The portfolio consisted of two main parts. In the first section, the students accumulated "proofs" of acquired skills or knowledge. A journal in which the students reflected on their learning in the chemistry class constituted the second portion of the portfolio. At the end of the year, the portfolios were analyzed in order to answer the question: "Can portfolios be used in a Chemistry I Honors classroom to increase student involvement in and understanding of their own learning, as well as increase student involvement in the administration of the class?" This study discusses the findings on each of these points, as well as covering the methodology for implementing the portfolio assessment, and detailing problems encountered throughout the year. Results showed that a portfolio can substantially increase communication between students and teachers, leading to speedy implementation of administrative and/or procedural changes. The portfolio also dramatically enhanced students' participation in their own learning, leading to development of higher order thinking skills such as analysis, synthesis, and evaluation.

S4.07

THEMES, INQUIRY AND COLLABORATION IN COLLEGE INTRODUCTORY BIOLOGY LABORATORY.
E. E. Harding and Marilyn Key, California State University, Fresno and Cathy Loving, Texas A&M

In a thematic approach to introductory biology laboratory for students with diverse preparations and abilities, a series of modules was presented. Each centered on a single theme or concept. Within each module, students were allowed to select the laboratory activities they performed. The activities, heterogeneous in level and content, generally emphasized inquiry. Student-originated experimentation was supported and rewarded. Students were assigned to groups, and group assessment was used to reward collaborative efforts. To determine the effectiveness of the approach and to guide improvements, several assessment instruments were used, including a course evaluation survey that students completed after the first module and at the end of the semester. Two cohorts of students have completed the course. Students' concerns about their partners' effects on their grades were largely relieved by mastery grading of laboratory reports. Group assessment motivated students to work harder. Students preferred selecting their own activities to working in unison with the rest of the class. Over half of the students felt comfortable designing their own experiments; 59% said that the opportunity to do so was important to them. Independent exploration helped them understand concepts and made them "feel like a scientist rather than just a student."

S4.08

INVESTIGACION EN EL SISTEMA EDUCATIVO TECNICO EN LOS PAISES INTEGRANTES DEL MERCOSUR
Jorge Bueno, Nelly Diaz, y Nancy Pere, Ministerio de Educación y Cultura del Uruguay, Uruguay

En la época de la ciencia y la técnica, la formación y educación constituyen, tanto para el individuo como para la sociedad en su conjunto, una importante inversión para el futuro. Este es el punto de partida de la política educacional técnica y de todas las medidas pedagógicas que tienen la convicción de que con ello se crean condiciones favorables para el desarrollo libre, multifacético y armónico de todos los hombres, exigiendolas al mismo tiempo imperiosamente para su propio desarrollo. La formación y educación deben preparar a la juventud para que, promueva activamente los procesos sociales y coopere de forma responsable y crítica en las distintas formas de la democracia, realizándose a si misma a través de ello.

S4.07

DESIGNING ALTERNATIVE ASSESSMENTS FOR A YEAR-LONG GARBAGE/ECO-SYSTEM UNIT: WHAT IT PORTENDS FOR THE EDUCATIONAL RESEARCHER

Julie A. Schmidt , University of Delaware
Jean Leach, West Park Place Elementary School
Shaunna Griffin, University of Delaware

The purpose of this case study was to investigate the results both for students and the teacher in expanding an existing third grade conceptual change garbage/eco-system unit from one month to a full year, and to describe the transition from a research-based clinical interview to a teacher-based alternative form of assessment all within the larger context of the state's standards-based reform effort. The results indicated that the transition was successful, that the expansion of the unit increased students' knowledge of decomposition, and that alternative forms of assessment proved invaluable for planning instruction. In addition, the results provoked new questions about the structure and benefit of assessments while signalling a fundamental shift from a researcher's to a teacher's agenda.

S4.08

GERENCIA DE INVESTIGACION PARA LAS UNIVERSIDADES PERUANAS
Esteban Castellanos, Universidad Católica del Perú, Perú

La aplicación de ciertos principios de gerencia de investigación a la formación de núcleos universitarios, que reemplacen o complementen los Institutos estatales desaparecidos o con escasos recursos económicos en el Perú tiene una importancia significativa en el desarrollo del país y la enseñanza de las ciencias exactas y naturales. Las universidades peruanas tienen el desafío de lograr la recuperación de la investigación en el Perú como consecuencia de un deasarrollo autosostenido de la enseñanza de las ciencias exactas y naturales. Como soporte se cuenta con la mayor comunicación y relaciones con investigadores peruanos en el exterior, la colaboración internacional y el desarrollo de los programas de postgrado. Por otro lado existen problemas económicos, poco interés y recursos de las industrias en un trabajo conjunto con las Universidades y falta de personal especializado.

S4.08

MEMORIA BILINGUE: ESTRUCTURA vs. PROCESOS MENTALES
Roberto Heredia, University of California, Santa Cruz, U.S.A

Este estudio investiga la organización de la memoria en sujetos bilingües. Anteriormente, se creía que las personas bilingües organizaban sus dos idiomas bajo un sistema linguístico en el cual ambos lenguajes eran almacenados en una sola memoria, o dos memorias totalmente diferentes, una para cada lenguaje. Sin embargo, actualmente se ha demostrado que no es necesario presuponer estructuras de almacenamiento, ya que tales hipótesis que enfatizan estructuras mentales no toman en cuenta diferentes tipos de procesos mentales, tales como, a) procesos conceptuales, y b) procesos perceptuales. La presente investigación reporta resultados experimentales que demuestran lo importante de tomar en cuenta el tipo de instrumento (variable experimental), y el tipo de procesos mentales en cualquier tipo de generalización acerca del almacenamiento de la memoria bilingüe.

S4.09

UNDERSTANDING GENERATIVE LEARNING MODELS OF INSTRUCTION BY ELEMENTARY TEACHERS TRAINED IN A LINEAR INSTRUCTIONAL PROCESS
Lawrence B. Flick, Washington State University

Generative learning models of teaching articulate the kind of instruction envisioned for systemic reform in mathematics and science education. However, they have not enjoyed as wide an acceptance in the educational community as more linear models of instruction. This study examines planning activities of the 18 teachers in one elementary school where the student population is 77% minority and where the principal is a strong instructional leader prescribing a linear, instructional process model. The teachers were engaged in designing integrated math and science units using a generative learning model of instruction. Tape recordings from planning sessions, teacher notes, draft and finished unit plans, and researcher field notes were systematically examined as texts of socially shared cognitive activity to determine understandings of the generative learning model presented. The analysis showed increased articulation of significant educational issues but also revealed conflicting relationships, for instance, between the function of instructional objectives and activities. Implications for systemic change in elementary science and mathematics education are discussed.

S4.08

ESTUDIANTES DE NUEVO INGRESO A LA CARRERA DE BIOLOGO MARINO EN LA UNIVERSIDAD AUTONOMA DE BAJA CALIFORNIA SUR, MEXICO
C. J. Villavicencio Garayzar, y María del Carmen y Gómez del Prado Rosas, Universidad Autónoma de Baja California Sur, México

Ingresan dos generaciones por año a la carrera de Biólogo Marino, una en enero y otra en julio, con caractersticas diferentes entre si; hay mayor demanda de ingreso de alumnos en Julio (en 1993 hubo 14 solicitudes en enero y 44 en julio), su edad promedio es menor (2.3 años) y obtienen calificación promedio ligeramente más alta en el examen de selección (3.5 centésimas) que los que ingresan enenero; sin embargo, no se observa una diferencia en el patrón de calificaciones por área de conocimiento, en ambas generaciones se tienen notas más altas en Biología y Geología, más bajas en Física y Matemáticas y regulares en Química y conocimientos generales. En los últimos años se ha observado una disminución en la demanda de ingreso, lo cual se relaciona con los problemas económicos del país, ya que anteriormente la principal demanda de la carrera era por estudiantes del centro del país, en la actualidad lo constituyen los alumnos del estado.

S4.09

A SURVEY OF INTERACTIVE VIDEO USE IN SCIENCE TEACHER EDUCATION IN OHIO
David D. Kumar, Florida Atlantic University
Stanley L. Helgeson and Deborah C. Fulton, NCSTL, The Ohio State University

Preservice science teacher education programs in Ohio (n=47) were surveyed to determine the status of interactive videodisc (IVD) use. Among other things, it was found that 14 institutions were currently using IVDs and 4 were implementing them. Most of the IVD use was with undergraduate elementary education majors. Average class size was 23 students with an average age of 26 years, and a female to male ratio of about 7 to 3. The major instructional purpose of IVD use was for teaching instructional strategies with teaching content second. Most IVD use was as part of methods classes followed by separate classes (computer based tools, astronomy/physics, instructional media). Most of the IVDs were purchased from vendors; a smaller proportion were custom developed. Lack of finances and equipment were the predominant reasons reported for not using IVDs, followed by lack of interest, time, knowledge, and familiarity. No studies of outcomes were reported for IVD use, evidence of the need for research regarding the effectiveness of interactive videodisc technology.

S4.09

DEVELOPMENT AND IMPLEMENTATION OF VISUAL/SPATIAL SCIENCE ACTIVITIES.
Alan J. McCormack and Cheryl L. Mason,San Diego State University

Visual/Spatial Thinking (VST) involves purposeful use of the mind's eye to develop mental pictures or images. This study culminates Phase 1 of Project VISTA - a research/curriculum development project involving classroom teachers, scientists, science educators, and cognitive psychologists in development and classroom implementation of science activities intended to enhance VST. Eighteen K-8 teachers participated in a VST Science Activities Development Institute. A battery of Likert-style and structured observational measures were employed to collect data , and statistical and naturalistic analysis techniques revealed positive attitudinal changes and enhancement of teachers'abilities both to develop and implement spatially-oriented.science activities. Subsequent phases of Project VISTA will measure the effects on K-8 children of a year-long sequence of VST activities blended into their classroom science programs.

S4.10

PREDICTORS OF SCIENCE FAIR PARTICIPATION USING THE THEORY OF PLANNED BEHAVIOR
Charlene M. Czerniak and Andrew T. Lumpe, The University of Toledo

The purpose of this study was to use The Theory of Planned Behavior (TPB) to examine factors that predict secondary students' attitude toward behavior (participating in a district science fair competition), subjective norm (who would approve or disapprove), and perceived behavioral control (over participating in the science fair). Factors used to predict these included gender, type of school (public or private), grade level, GPA, participation in a gifted class, participation in a research course, requirement to complete a science fair project, and level of anxiety about completing a science fair project. 455 participants completed a standard TPB questionnaire and the State-Trait Anxiety Indicator. Multiple regression models found that grade level, GPA, being required to complete a science fair project, and level of anxiety toward completing a science fair project were predictors of attitude toward the behavior. No variables predicted subjective norm. A discriminant function analysis found that grade level, science fair project counting as a course grade, ABI, school type, participation a gifted course, and participation in a research course were the strongest predictors of perceived behavioral control.

S4.09

"GALILEO REVISITED": CASE STUDIES AND THE PROFESSIONAL DEVELOPMENT OF SCIENCE TEACHERS
John Wallace, SMEC, Curtin University of Technology and William Louden, Edith Cowan University

This study examines the potential of case methodologies for the professional development of science teachers. Teachers were asked to prepare a brief case study or story of their own teaching. In order to focus on their reflection on the cases, teachers were asked to collect a set of written commentaries, one by a beginning teacher, another by an experienced teacher and a third by the teacher him/herself. Generally, the teachers found the writing of the cases to be a useful way of confronting problems or celebrating successes in teaching. The standard of the commentaries tended to be disappointing – the best commentaries were received from the more experienced teachers. Finally the quality of collegial relations between the teacher and the commentator often determined whether this kind of reflection could enable wider possibilities for professional developm nt.

S4.10

DO SCIENCE TEACHERS INTEND TO ENGAGE IN COLLABORATIVE REFLECTIVE PRACTICE?
Shireen J.M. DeSouza. Georgia Southwestern College, Americus, Georgia.

This study was designed to determine science teachers' intentions to engage in collaborative reflective behaviors. Three behaviors characteristic of collaborative reflective practice were identified: 1) science teachers collaborating with their colleagues to inquire into the needs and abilities of their students, 2) science teachers providing instruction for students from diverse backgrounds after reflection and feedback from their colleagues, 3) science teachers having their teaching performance evaluated by their colleagues. Two hundred and eighty five science teachers from elementary, junior high, and secondary schools in the State of Ohio participated in the study. Science teachers' beliefs about engaging in reflective practice were elicited. The Collaborative Reflective Questionnaires A, B, and C were developed from these elicitations. The questionnaires measured science teachers intentions, attitude toward behavior, subject norm, and perceived behavioral control of the three collaborative reflective behaviors. The data was analyzed using Pearson's product correlations, simple and multiple regression equations and analysis of variance. Science teachers' attitude, subjective norm and perceived control of reflective behaviors could predict their intentions to engage in a specific behavior.

S4.10

THE DETERMINANTS OF CHEMISTRY STUDENTS' INTENTIONS TO MAJOR IN SCIENCE: A LISREL MODEL USING AJZEN'S THEORY OF PLANNED BEHAVIOR.
Lee Meadows, The University of Alabama at Birmingham; J. Steve Oliver and Thomas R. Koballa, Jr., The University of Georgia

The determinants of students' intentions about continuing a science or science-related major were analyzed using Ajzen's theory of planned behavior and structural equation modeling with LISREL. The population under study was students taking a general chemistry course required for science or science-related majors at a major research university in the southeastern United States. Close-ended questionnaires were administered to 598 students in their last week of a two-quarter sequence, and student responses were used to generate a structural equation model of the students' intentions about their majors. Students' personal attitudes were found to be the only significant determinants of intention. Subjective norm, perceived behavioral control, and beliefs were not found to contribute significantly to intention.

S4.11

APPROPRIATING SCIENTIFIC DISCOURSE IN A SIXTH GRADE CLASSROOM: THE CASE OF JUAN.
David Holland and Charles W. Anderson, Michigan State University, and Annemarie S. Palincsar, University of Michigan

This study analyzes how the members of one small group negotiated understanding and role relationships while working on a complex scientific problem: using molecular models to explain a demonstration that included evaporation and condensation. Juan, a Latino boy, was fascinated by the molecular models, staying after school to work with them. As a result of a series of episodes involving Juan, his teacher, and other members of the group, however, Juan's role in the group was ultimately limited to making the models themselves, while a more academically successful student developed the explanations that used them. This paper points out both the promise and the difficulty of having students work together on "authentic" scientific problems. When the problems are truly complex enough to be challenging, members of student groups (like adults) often find it difficult to negotiate productive roles that involve all the members of the group in understanding and using scientific principles. This study helps us to analyze the nature of the challenges that we face and begin developing appropriate instructional responses.

S4.10

TEACHERS' INTENTIONS TO USE AND THEIR ACTUAL USE OF MICROCOMPUTER SCIENCE LABORATORY INTERFACE MATERIALS IN SCIENCE EDUCATION
Bruce G. Smith, Edinboro University, Pennsylvania; Frank E. Crawley, University of Texas at Austin; and Robert L. Shrigley, Pennsylvania State University.

This investigation examined the beliefs, intentions, and behavior of science teachers following inservice training, regarding the implementation of an educational innovation. Science teachers were trained to use microcomputer science laboratory interfacing (MSLI) materials in their classes. Using the theory of planned behavior to guide the study, we explored three key connections: 1) the link between materials use and teachers' intentions to do so after training, 2) the link between teachers' intentions and their attitude, social support, and sense of control regarding materials use, and 3) specific beliefs that teachers held about MSLI materials use. We found that teachers committed to using the materials did so. Commitment was traced to teachers' personal attitude toward materials use and their control over the implementation decision. Of primary importance were teachers' beliefs that students would become involved, learn science in an integrated fashion, and learn less discipline-specific content. Teachers also reported that they needed time to practice and to work the materials into their curriculum.

S4.11

POWER, STATUS, AND PERSONAL IDENTITY IN SMALL GROUP PROBLEM SOLVING
Gwen M. Kollar and Charles W. Anderson, Michigan State University, Annemarie S. Palincsar, University of Michigan

This study describes a group of students who worked together on a problem designed to promote engagement and understanding in a middle school science classroom. The degree to which those outcomes were achieved depended on many factors, especially the personal histories and interactions among the group members. Two particular days were targeted, transcribed, and analyzed to help us understand the students' interactions. We focused on the manner and degree of engagement for each student, and on the needs or agendas that seemed to motivate students. These personal agendas and the students' personal histories influenced their status and power within the group and the roles that they played in group activities. In this group all students were able to develop scientific understandings of the problem. The question remains whether working collaboratively helped the lower-status students create understandings richer than those created in more traditional classrooms.

S4.11

STUDENT ENGAGEMENT IN SCIENCE COLLABORATIVE GROUPS.
Lori A Kurth and Charles W. Anderson, Michigan State University; Annemarie S. Palincsar, University of Michigan

This study examines in detail the dynamics of a collaborative group of four sixth grade students working on a beginning liquid density unit. In particular, the effects of student interactions on individual engagement within the community setting were investigated. The time period involved a ten day unit in which the group under study was videotaped daily with the use of desk microphones to closely track their conversations. The analysis focused on the engagement of one student, an African American girl, whose efforts to interact with the rest of the group were often unsuccessful. Differences in conversational patterns between the focus student and the white members of the group appeared to cause confusion and frustration. In addition, dissimilarities in race, status and style created tensions and misunderstanding as the group members worked together. The teacher's intervention helped to avoid conflicts but did not resolve the underlying difficulties associated with differences in conversational style and approach to science. Since many educators believe that student construction of scientific knowledge is best generated in a collaborative group setting, the ability of individual students to engage in a group learning environment must be assessed.

S4.12

WHEN WORLD VIEWS COLLIDE: CONFLICTING BELIEFS ABOUT ASSESSMENT IN AN INTERDEPARTMENTAL EFFORT TO DEVELOP A BIOLOGY COURSE FOR PROSPECTIVE ELEMENTARY TEACHERS
Susan A. Mattson, Florida State University

Interdepartmental efforts to redesign science courses for prospective teachers are relatively rare. Persistent administrative and social barriers have limited communication, cooperation, and even tolerance among members of different disciplines. For this reason, the social process of "crossing disciplinary boundaries" to collaborate on course development becomes an interesting phenomenon in itself. This research involves a case study of an interdepartmental effort to develop a biology course for prospective elementary teachers and focuses on the issue of assessment. Two conflicting clusters of beliefs about assessment emerged with regard to its appropriate nature, purpose, locus of control, and degree of integration into learning activities. Although the course was intended to reflect the goals of reform in science education, traditional beliefs and resulting actions dominated how assessment was ultimately implemented. The implications of this for the prospective teachers involved and science education as a whole are discussed. The seemingly inherent problems of collaboration between faculty in Colleges of Arts and Sciences and Education and their potential solutions are also considered.

S4.12

EXPLORING CHEMISTRY TEACHERS' BELIEFS ABOUT STUDENTS' LEARNING PROCESSES
Robert E. Hollon, Patricia K. Freitag, and Lyman L. Lyons, WCER

The purpose of this research was to (a) describe high school chemistry teachers' beliefs about students' learning processes and (b) illustrate how teachers' reflective analysis of researchers' interpretations increases the validity of assertions while revealing additional dimensions of underlying beliefs. Four experienced teachers were observed and interviewed about their teaching of stoichiometry, atomic structure, and acids and bases. Knowledge-in-action descriptions were developed from observations, interpretive field notes, and interview data, after which each teacher read and discussed the analysis in an interview. For two teachers, the coherence between thoughts and practices was evident and supported in their analyses. Congruence between analyses and action was much lower for the other teachers and was accounted for in unique ways. All four teachers used similar language to discuss students' learning processes, however the meaning associated with the language was unique to the individual.

S4.12

SCIENCE MIDDLE SCHOOL TEACHERS GENDER RELATED BELIEFS, AND THE ACHIEVEMENT OF THE COMPREHENSIVE PLAN GOALS IN FLORIDA
Lilia Reyes-Herrera, Florida State University, Univ. Pedagógica Nal. Colombia., Alejandro Gallard and Scott Robinson, Florida State University.

The purpose of this paper is to identify the importance teachers assign to certain issues that could influence the way they teach. This study is part of a larger effort of evaluating the implementation of Florida's Comprehensive Plan in regards to Middle School Science Education.The "Mann- Whitney" test was used to assist us in making generalizations about female and male teachers with respect to some issues that contribute to the enhancement of the goals of the comprehensive plan. Four findings are of special interest, these include: 1. -Female teachers believe that working in cooperative groups is more important than male teachers. 2. -Female teachers believed that student discussions were more important than male teachers. 3. -Male teachers are more likely than female teachers to integrate science lessons into other areas of the curriculum. 4. -Male teachers used manipulatives more often than female teachers. The way teachers perceive their role working with their students has profound implications in her-his decision making process in the classroom.

S4.12

PATTERNS OF TEACHER PRACTICES, BELIEFS AND NEEDS: SOCIO-ECONOMIC FACTORS AND SCIENCE INSTRUCTION IN MIDDLE SCHOOLS
Scott Robinson, Kenneth Tobin & Kenneth Shaw, Florida State University

As a part of a statewide survey of what is happening in Florida's schools we analyzed the data we received from questionnaires in terms of socio-economic data for the students taught by the teacher respondents. A sampling of the results obtained are provided below.

- Teachers from schools with a medium percentage of low socio-economic level (SEL) students have more need of workbooks and worksheets, use workbooks and worksheets more frequently, and believe these instructional items are more important than teachers from schools with a low percentage of low economic students.
- Teachers from schools that have a low percentage of low SEL students use manipulatives more often and believe it is more important to do so than teachers from schools with a medium or higher percentage of these students.

The results of our study suggest that the reform of science is not proceeding according to plan. Teachers are not in a process of reform and when expressed needs are compared to what is envisioned in reform documents there is a clear need for effective systemic science teacher education.

S6.01

PROFESSIONAL DEVELOPMENT AND GENDER ISSUES: MODELS AND FRAMEWORKS
Sharon Parsons, San Jose State University, Lesley Parker and Léonie Rennie, Curtin University of Technology, Gaell Hildebrand, University of Melbourne

This symposium concerns professional development for teachers in the light of challenges posed to current practice by feminist approaches to research in science education. Progress in research and curriculum developments relating to gender-inclusive teaching practices has created a need for programs of professional development about gender issues. Experience indicates that program success is not assured without a high degree of involvement by teachers and responsiveness by designers to the needs of teachers as their practices evolve. The more effective programs seem to be those which model the collaboration, reflection and sharing characteristics of the gender-inclusive classroom practices which are their focus. This symposium presents an overview of models relating to feminist frameworks for analyzing teacher change, describes three approaches to professional development to facilitate teacher change, and concludes with an analysis of our learning from our experiences in professional development relating to gender issues in science education.

SUNDAY -- AFTERNOON

S5.13

TEACHING AND LEARNING STRAND DISCUSSION (1-1/2 hours) ALTERNATIVE PERSPECTIVES OF TEACHING, LEARNING AND ASSESSMENT: DESIRED IMAGES
Katherine M. Fisher, California State University, San Diego, Ron Good, Louisiana State University, Sister G. Hennessey, St. Ann School, Stoughton, WI, Wolff-Michael Roth, Simon Fraser University, James A Shymansky, University of Iowa, Larry D. Yore, University of Victoria

In a recent JRST Editorial, Ron Good (1993) suggested that "pub talk" during informal graduate seminars revealed many faces of constructivism and an apparent lack of clarity in terms of classroom expectations. The lack of distinctions and consistencies apparent in the "pub talk" frequently creep into other published conversations about science teaching and learning. The last 10-15 years of science education research has produced some insightful descriptions and embryonic generalizations of teaching, learning and assessment, but the multiple interpretations of these original works have rightly or wrongly clouded their distinctive differences. Brief presentations at this discussion will outline desired images of teachers and teaching, students and learning, and goals and assessment from specific perspectives: conceptual change, information processing, interactive-constructive, and social-constructivist. The presenters promise to provide an informative and provocative introduction for an open and stimulating discussion. These discussions should bring classroom practices into sharper focus and help teacher/learning researchers pose more acute questions, design more strategic inquires, develop richer discussion of research results, and propose more insightful implications.

S6.02

Students' use of a multimedia interactive science unit and the relation to problem solving.
Jane Tucker and Carl Berger, University of Michigan

The purpose of this study was to find students' problem solving profiles and their relation to their use of a microcomputer supported science instructional program. A multimedia interactive program was used as the learning environment. The program contained screens of information in text and picture form, animation, and simulation. Students could navigate by clicking on icons that initiated the next event or state of learning. Students problem solving profiles were determined using the Problem Solving Inventory, a multidimensional survey that measured problem solving consistency, planfulness, persistence, innovation and problem view. Program data were gathered automatically in log files and over 1,670 state changes were analyzed for 18 students . Results indicated that students varied widely in the use of the program, what they studied and how deep into each section of the program they went. Students problem solving profiles related to movement, and depth of study but what they studied depended on personal interest. The use of a problem solving profile lend can assist science educators and teachers in understanding the different ways students approach learning situations and how they work through science problems Instructors using such tools can be more confident that needs of diverse student populations may be met by interactive multimedia programs.

S6.02

STUDENT-STUDENT INTERACTIONS GENERATED BY THE INTRODUCTION OF INTERACTIVE VIDEODISC IN THE SCIENCE CLASSROOM

Isabel Chagas, Universidade de Lisboaand and Gerald Abegg, Boston U.

This study was designed to analyze the classroom interactions experienced by sixth graders while working with the interactive laser videodisc on a science topic. It was assumed that the understanding of such interactions would clarify the impact of the interactive videodisc (IVD) as an instructional tool. Subjects were 107 science students, the total population of the sixth graders of a middle school in the northeast. Using qualitative research methodology, classes using IVD materials were observed. Students' conversations were audiotaped, and non-verbal episodes registered. The data showed IVD's major impact concerned the classroom's social structure. New interactions between the teacher and students empowered students with greater access to the technology as well as with more control over their learning environment. Students engaged in a complex interactions in order to clarify their colleagues' questions, make doubts clear and understandable to others, test hypotheses together, discuss results and make predictions. They also engaged in discussions in order to make sense of what they were watching, to negotiate different points of view, and to explain details to their colleagues having difficulties. Students communicated both verbally and non-verbally.

S6.03

COPs AND ANTs: TRACKING SCIENCE LEARNING IN SOCIAL SETTINGS

Wolff-Michael Roth, Simon Fraser University

The recent focus on social aspects of science learning necessitates research methodologies that expand and transcend the narrow confines of those methods which had been designed from the perspective of an individual difference cognitive psychology. Communities of Practice (COPs) and Actor Network Theories (ANTs) are two approaches which have already been successfully applied to knowing and learning in the context of science and technology. This paper outlines the notions of *COP* and *ANT*, and how they are used to understand and conceptualize knowing and learning in complex settings. From these notions I draw methodological implications, and discuss the analytical opportunities afforded by the perspectives of *COP* and *ANT* along continua marked on either end as insider/outsider, visible/invisible, violence/empathy, fixed/dynamic, or voice/silence. I discuss two research settings are discussed in which this framework was developed and used.

S6.02

HUMAN PHYSIOLOGY: IMPROVING STUDENTS' ACHIEVEMENTS THROUGH INTELLIGENT STUDYWARE

Yehudit J. Dori, Technion, Israel Institute of Technology, Haifa , Israel and Jerome M. Yochim, University of Kansas, Lawrence, Kansas.

A studyware comprising a set of inter-connected modules on human physiology has been developed and used to improve undergraduate students' achievements. Using the study modules, students can engage in active learning and enhance their spatial and problem solving abilities, while the system monitors their responses and reacts accordingly. A key factor in this system is the enabling technology of multimedia, which opens the way for the creation of a multi-faceted learning environment and rapid development of effective and attractive learning materials. The results of the study show that the final grades can be best predicted by the entry level of the students, as reflected in their biology grades. A secondary consideration in this prediction is whether the individual student used the optional computer laboratory sessions offered to him/her as a means of fostering the subject matter understanding and his/her problem solving abilities.

S6.03

USING CONCEPT MAPPING IN A COLLEGE COURSE ON EVOLUTION: PHASE 2 – INTEGRATION OF INSTRUCTOR-SUPPLIED GRAPHICS IN STUDENTS' MAPS

John E. Trowbridge and James H. Wandersee, Louisiana State University

The purpose of this phase of a two-year study was to: (a) describe how concept mapping can be used as an integral instructional strategy for teaching a college evolution course, (b) evaluate the utility of incorporating concept mapping in a college course on evolution, (c) determine the effect of instructor-supplied graphics on students' concept mapping, and (d) compare students' concept maps for the same class over a two-year period. Key findings include (a) students who are persistent mappers seem to correlate to instructor supplied graphics with higher concept map scores, (b) males correlated higher in terms of average map scores and number of instructor-supplied graphics, however, females had a higher grade point average and average map score, (c) the appearance of critical juncture days was observed by the disconcordance of superordinate concepts and low average number of cross links on specific lecture days, (d) the three largest percentages of instructor comments (linkages, examples, cross links) were the same as in Phase 1 of this study, (e) the same lecture days in Phase 1 and Phase 2 showed concordance and disconcordance of superordinate concepts reinforcing reliability of such methods for determining critical junctures.

S6.03

TEACHING FOR STUDENT CONCEPTUAL UNDERSTANDING IN SCIENCE: RESEARCH IMPLICATIONS FROM AN INTERDISCIPLINARY PERSPECTIVE

Michael R. Vitale, East Carolina University, Nancy R. Romance, Florida Atlantic University, Helen Parke, East Carolina University, and Pat Widergren, Silver Ridge (Ft. Lauderdale, FL) Elementary School

This paper identifies specific implications from recent developments in cognitive science (including artificial intelligence) and instructional design (or instructional science) for research in science education designed to explore teaching for student conceptual understanding. In doing so, the paper (a) overviews the major areas of research in science education, cognitive science, and instructional design that address questions of teaching for conceptual understanding (in terms of findings, similarities/differences in research perspectives, and research questions/methodology), (b) employs a recently-developed knowledge-based science teaching model emphasizing conceptual understanding (Romance, Vitale, & Widergren, in press) as a vehicle for integrating current research and theory in science education with complementary research findings from cognitive science and instructional design, and (c) identifies specific substantive and methodological research issues and priorities for science education research in teaching for conceptual understanding in science that follow from the interdisciplinary perspectives incorporated in the model (Romance et al, in press) through the integration of research in science education, cognitive science, and instructional design.

S6.04

TEXTBOOK USE IN THE HIGH SCHOOL BIOLOGY CLASSROOM: WHAT TEACHERS REPORT.

Lori Lyman DiGisi, Lesley College

This study describes high school biology teachers' reports of their textbook use and instructional practices. Eighty percent of 184 teachers responded to a mail questionnaire that gathered information about textbook use, attitudes about reading and biology textbooks, and instructional practices. Sixteen teachers, broadly representative of the questionnaire sample, were interviewed. Both quantitative and qualitative analyses were used to process the data. Results from multiple regression analyses revealed that academic level of biology, teachers' ratings of the importance of reading, and placement in a public or private school predicted 60% of the variation in teachers' reported textbook use. Teachers also reported that biology teaching experience, achievement tests, and courses in reading instruction influenced their textbook use. Results suggest that high school biology teachers view both reading and inquiry-based activities as important to learning biology, but they are unsure of how to incorporate reading comprehension activities into their biology instruction.

S6.03

IMPLEMENTING REFORM IN RURAL HIGH SCHOOL SCIENCE CLASSROOMS: A CASE STUDY OF TWO PHYSICAL SCIENCE TEACHERS

Susan L. Westbrook and Laura N. Rogers, North Carolina State University

This case study of two rural high school science teachers was undertaken to assess the efforts necessary to prepare science teachers in North Carolina to make the changes necessary to align classroom practice with educational research. The project goals included (a) enhancing the classroom teacher's awareness of the reform agenda for science education, (b) mentoring and facilitating the implementation of learning cycle curriculum , (c) assessing the effect of an innovative implementation model on the pedagogy and epistemology of the classroom teacher, and (d) preparing the classroom teacher for a leadership role in the local school district. The data indicate that (a) the involvement of university personnel had a positive impact on administrative support for teacher change, (b) the rate of change in teacher reform is variable and unpredictable and may not be accurately reflected by the teacher's self-perception, and (c) consistent in-classroom support is essential for major changes in a teacher's classroom practice. Delineation of the impact the teachers' belief and practice paradigms had on implementation of the curricula will be discussed.

S6.04

VERBAL AND NON-VERBAL BEHAVIOR OF ABILITY--GROUPED DYADS

M. Gail Jones, University of North Carolina
Glenda Carter, N.C. State University

This study examines social interactions of ability-grouped studentdyads as they construct knowledge of balance concepts in order to elucidate the relationship between interactions and conceptual growth. The verbal and nonverbal behaviors of 30 fifth-grade students were recorded as they completed three activities related to balance. These student interactions were examined within a framework of social cognition. For each dyad, characteristics of ability-grouped dyads were identified. Results revealed that high students effectively use prior experiences, maintain focus on the learning task, and are able to manipulate the equipment effectively to construct knowledge. Low students exhibited off-task behavior, lacked a metacognitive framework for organizing the learning tasks, centered on irrelevant features of the equipment and were unable to use language effectively to mediate learning. Within low-high student dyads, high-achieving students typically modeled thinking processes and strategies for manipulating equipment. In addition, they focused the low-achieving student on the components of the tasks, while verbally monitoring their progress, thus enabling the low student to identify the critical features necessary for concept construction.

S6.04

AN INTERPRETIVE STUDY OF PAIR INTERACTIONS SUPPORTING THE COMPOSITION OF COLLABORATIVE LABORATORY REPORTS IN NINTH GRADE GENERAL SCIENCE
Carolyn W. Keys, Georgia State University

The purpose of this study was to identify and describe the types of collaborative interactions which supported the joint composition of laboratory reports and to investigate changes in collaborative interactions over time. Three case study pairs of students were chosen from ninth grade classes participating in a collaborative writing intervention. Students wrote ten reports over a four and one-half month period. The author and the classroom teacher provided structural report guidelines to scaffold student pairs in report writing. The results indicated that students spontaneously engaged in five types of interactions, which were named by the author; sounding board, peer teaching, incorporation, debate, and supplies answer. The majority of pair interactions were cooperative and generative. Two target pairs increased their ability to extend and elaborate conceptual discussions over time, while a third pair demonstrated little change. An increase in elaboration corresponded with an increase in the active participation of one of the members of the pair.

S6.05

THE CLASSROOM AS A SOCIOCULTURAL SITE: TOWARD MORE INSIGHTFUL UNDERSTANDINGS OF WAYS OF KNOWING AND ACTING
William W. Cobern, Arizona State University West
Peter C. Taylor, Curtin University
Kenneth G. Tobin, Florida State University

We believe that much of the past conceptual change research in science education has been based on simplistic notions of epistemology, including a positivist view of the nature of science and a rationalist view of teaching and learning. Although this research has focussed pedagogical attention on students' conceptions, the complex social reality of the classroom, including the ethical question of what *should* be going on, has been largely ignored. The aim of this symposium is to provide greater insight into the social reality of the science classroom and to provide directions for future research in science education. We believe that research in science education, especially research within a *constructivist* framework, should examine a broader range of epistemologies, especially those that acknowledge the sociocultural context of knowledge development and that help us to generate more insightful understandings of the ways in which we come to know about our worlds. Issues to be addressed in the symposium include: (1) the importance of students' *world* views as a context for studying science; (2) adding communicative understanding and critical awareness to classroom discourse; and (3) beyond propositional logic: the central role of beliefs, metaphors and imagery in shaping teacher and student classroom roles.

S6.04

EVALUATING THE PAIRS PROJECT: INTEGRATING READING AND SCIENCE
Mark R. Malone, University of Colorado

The PAIRS Project was funded by a federal grant to prepare elementary and middle school teachers to utilize an integrated approach to science and reading instruction. The evaluation portion of the program was designed for two purposes: (1) to ascertain the effectiveness of the teacher training program on both the knowledge and attitudes of teachers, and (2) to measure the effectiveness of PAIRS activities on intermediate elementary and middle school students in terms of knowledge and process skills. The study involved approximately 30 teachers and 700 elementary and middle school students. Participating teachers received 30 hours of specialized training and were provided with classroom materials. The evaluation of this project indicates that teachers have benefited by both improved attitudes toward science and science teaching and through increased understanding of contemporary science teaching. As a result they were able to teach science to students in a wide variety of settings in such a way that resulted in significant learning. The students gained science knowledge and skills which were measured to be significant. Students were able to apply specialized skills to reading science that enabled them to make these gains.

S6.06

SYSTEMIC REFORM IN SCIENCE EDUCATION: COORDINATING RESEARCH BETWEEN AN URBAN SYSTEMIC INITIATIVE AND A STATE SYSTEMIC INITIATIVE IN OHIO.
Jane Butler Kahle, Ann Haley-Oliphant, and Steven Rogg, Miami University

The purpose of this symposium is to provide an opportunity to discuss the current research coordination occurring between a state systemic initiative and an urban systemic initiative in Ohio. Qualitative and quantitative methodologies were used to determine the similarities and differences of these two groups of teachers in terms of their professional involvement, knowledge of pedagogical methodologies, use of alternative teaching strategies, and whether they view themselves in a visionary or traditional way. Detailed portraits of the urban teachers teaching math and science were made in order to better understand the barriers, struggles, and opportunities existing in an urban setting. By coordinating the research of these two initiatives, the current systemic reform movement in science education can be enriched and empowered.

S6.07

TEACHING THE NATIVE AMERICAN STUDENT: TEACHERS' BELIEFS ABOUT MULTICULTURAL SCIENCE EDUCATION.

Diane Ebert-May, Northern Arizona University; Deborah Tippins, University of Georgia; Carol Adkins, Northern Arizona University; J. Shiro Tashiro, Northern Arizona University; & Paul Rowland, Northern Arizona University

The purpose of this interpretive study was to examine the beliefs of Native American teachers with regard to a) the goals and aims of multicultural science education; b) responsiveness to cultural difference in the planning of science instruction, and c) conceptions of culture form a world view perspective. Participants in the study were practicing Native American elementary teachers involved in one of three related science programs between 1991-1993: Teacher Network Teams (TNT), Science and Mathematics for Indian Learners and Educators (SMILE), and Collaborating Across Cultures to Understand Sciences (CACTUs). A task was presented to teachers in each program to investigate beliefs about responsiveness to cultural difference in planning science instruction. Teachers in the CACTUs institute, for example, were asked to describe in detail a lesson designed to teach a specific science concept to Native American students, and one designed to teach the same concept to non-Native students. Results revealed that a) the role of the larger tribal community and sociocultural factors outside the school influenced the interpretation of the goals of multicultural science education; b) responsiveness to cultural difference involved a holistic understand of basic values that move beyond an understanding of individual differences; c) teachers viewed culture and its relationship to science through "a multitude of cross-cutting, overlapping 'cultural worlds.'

S6.07

IMPACTING ELEMENTARY TEACHERS' BELIEFS AND PERFORMANCE THROUGH TEACHER ENHANCEMENT FOR SCIENCE INSTRUCTION IN DIVERSE SETTINGS

Iris M. Riggs, Esteban Diaz, Joseph Jesunathadas, Klaus Brasch, Javier Torner, Lisa Shamansky, Sam Crowell, and Allan Pelletier, California State University, San Bernardino

An assessment of a National Science Foundation teacher enhancement project's impact on elementary teachers' beliefs, attitudes, and teaching performance including: self-efficacy and outcome expectancy beliefs related to science teaching, beliefs about what is important in science teaching and learning, and quality and quantity of activity-based science teaching. Findings from analyzed pre/post belief and attitude assessments, self-report data, and classroom observation will be reported.

S6.07

AN INSTRUMENT TO ASSESS PRESERVICE ELEMENTARY TEACHERS' BELIEFS ABOUT SCIENCE TEACHING AND LEARNING

Sheila M. Jasalavich, University of Maryland at College Park
Larry E. Schafer, Syracuse University

The purpose of this study was to develop a valid and reliable instrument to assess preservice elementary teachers' beliefs about science teaching and learning. After several rounds of expert review and initial field-testing of a draft of the instrument, a revised version of the instrument was administered twice to 270 preservice elementary teachers to establish test-retest reliability. An estimate of internal consistency was obtained by calculating the Cronbach's coefficient alpha for each subscale of the instrument. Additional analysis of the subscale items was undertaken through factor analysis. Concurrent validity was assessed by correlating scores on the instrument under development with scores on measures of teacher learning orientation and control orientation. Preservice teachers' scores were further interpreted by examining their stated reasons for their responses to selected items. Additional insight about the reliability and validity of the instrument was obtained byexamining the relationship between inservice teachers' scores on the instrument and their general teaching orientation and current science teaching practices. The results of this study are that three of the four subscales of the instrument are fairly reliable.

S6.08

LOS DESCONCEPTOS INDUCIDOS EN LA ENSENANZA DE LA QUIMICA

Edgardo R. Donati, Daniel O. Martire, y J.J. Andrade Gamboa, Universidad Nacional de La Plata, Argentina

En los cursos básicos de química suelen observarse graves falencias en los alumnos. La responsabilidad de muchas de estas falencias puede adjudicarse al docente, el cual puede contribuir de diversas maneras que van desde la simple omisión de una nomenclatura común hasta la exigencia de ciertos procesos lógicos, que el alumno aún no ha adquirido y que el docente supone naturales por tenerlos él mismo demasiado arraigados. En este trabajo mostramos dichas falencias a través de la discusión de ejemplos concretos sobre desconceptos habituales en los alumnos del primer curso de química universitaria.

S6.08

REDES CONCEPTUALES PARTE 1: FUNDAMENTO TEORICO
Lydia Galagovsky, Universidad de Buenos Aires, Argentina

Bajo el nombre de mapas y/o redes, con el adjetivo de semánticas y/o conceptuales, existen numerosas organizaciones gráficas. Al intentar aplicar a situaciones didácticas, instrumentos tales como los mapas conceptuales utilizados en investigación sobre aprendizaje, surgieron graves inconvenientes. La superación de los mismos condujo a la definición de un nuevo recurso didáctico: la red conceptual, nombre que hasta el presente ha sido utilizado ambiguamente. En este artículo se presentan tanto las precisiones para su confección como el fundamento de su aplicación didáctica, ambos aspectos están sustentados en sólidos contextos teóricos, con aportes de la psicologística y de la neurobiología del aprendizaje, respectivamente.

S6.08

LA IMAGEN HACIA LAS CIENCIAS DE LOS ESTUDIANTES DE BIOLOGIA: UN ANALISIS EPISTEMOLOGICO
William Manuel Mora Penagos, Universidad Pedagógica Nacional, Colombia

El empirismo-inductivismo, y el racionalismo Popperiano son las visiones con que, en mayor medida, los estudiantes interpretan y entienden las ciencias; siendo el empirismo- inductismo la más influyente. Hay un desconocimiento tanto conceptual como actitudinal de otras formas de entender lo que son las ciencias como por ejemplo las posiciones de Kuhn, Lakatos, Feyeraben, Toulmin, Newton-Smith, entre otras posturas modernas que hoy por hoy son más aceptadas. Los estudiantes tanto de educación media como universitaria muestran en gran medida, una imagen en la que se entienden las ciencias como instituciones "religiosas" poseedoras de un conocimiento superior; descubridora y acumuladora de conocimientos verdaderos, caracterizados por ser inmutables y logrados a través de único método con características empiristas- inductivistas. Esta imagen puede acarrear consecuencias lamentables tal como el estancamiento o el lento progreso del desarrollo de las ciencias y la tecnología de una sociedad. Esta imagen además genera la idea que las ciencias son para unos pocos privilegiados, una serie de "sacerdotes con bata blanca", dotados de unas cualidades únicas que les son inaccesibles a los individuos comunes y a las sociedades poco desarrolladas, de esta manera generan altos niveles de deseción en estudiantes que pretenden seguir estudios que tengan que ver con las ciencias.

S6.08

PRECONCEPTOS Y SU REPRESENTACION EN CONCEPTOS BASICOS DE GENETICA
S. M. E. Jerezano, Z. C. Alvarado. C. F. Flores, C. L. Gallegos, Universidad Nacional Autónoma de México, México

Una de las áreas de la Biología que presenta mayor dificultad tanto para maestros como para alumnos es el tema de Genética. Este trabajo presenta un análisis de las preconcepciones que tienen estudiantes del nivel bachillerato en cuanto a: a) herencia de características heredadas; b) transmisión de caracteres; c) representación de cromosomas; y d) manejo de conceptos básicos. Se diseño un cuestionario de 24 reactivos que fué aplicado a una muestra de 342 estudiantes de los sistemas de la Escuela Nacional Preparatoria y Colegio de Ciencias y Humanidades. La muestra fue seleccionada de 7 de los 14 planteles de la Universidad Nacional Autónoma de México. Una selección de 30 estudiantes fué entrevistada para profundizar sobre las respuestas del cuestionario. Cabe señalar que todos los estudiantes habían cursado un año ante la materia de Biología General en la que se incluye una breve introducción del tema de Genética. Los resultados muestran la presencia de preconcepciones fuertemente arraigadas que impiden el manejo conceptual correcto, como puede ser la consideración de que las características adquiridas son hereditarias; no se tienen esquemas claros de representación; se confunden conceptos y términos entre otros.

S6.09

STUDENTS' ATTITUDES TOWARDS SCIENCE, TECHNOLOGY AND MATHEMATICS SUBJECTS IN SECONDARY SCHOOLS - THE JETS OF NIGERIA EXPERIENCE
Rose N. Agholor and Leonie J. Rennie, Curtin University of Technology, Perth, W. Australia and Peter A. O. Okebukola, Lagos State University, Lagos, Nigeria.

The Junior Engineers, Technicians and Scientists (JETS) programme is a non-formal educational strategy for promoting scientific and technological literacy among Nigerian youth. This paper reports a part of a larger study of the effects of the JETS programme as an out-of-class mechanism for fostering the development of science and technology culture among youth. In this study, students' attitudes towards, and perceptions about science, mathematics and technology, are reported. For each subject, students' enjoyment, and their perceptions of its easiness and importance, were surveyed using a semantic differential instrument. Over 1000 secondary school students from all over Nigeria took part in the study. The findings show consistently more positive attitudes and perceptions of JETS Clubs members compared to the non-members. Perhaps surprisingly, in terms of current perceptions in the literature, there was a consistent gender effect. Both boys and girls have positive attitudes to these three subject areas

S6.09

HIGH SCHOOL STUDENTS UNDERSTANDINGS OF DIFFUSION CONCEPTS IN RELATION TO THEIR LEVELS OF COGNITIVE DEVELOPMENT

A. Louis Odom, University of Missouri-Kansas City and John Settlage, Jr., Cleveland State University.

Tests were administered to 116 high school students to assess their level of cognitive development and their understanding of concepts related to diffusion and osmosis. The content instrument, the Diffusion and Osmosis Diagnostic Test (DODT), is of a two-tiered design allowing the assessment of the reasons behind the students answers. With no statistically significant differences in the scores on the DODT between concrete and transitional reasoners, the analysis compared preformal to formal thinkers. Statistically significant differences were found between the two groups of students in their understanding of the majority of the concepts addressed by the DODT. The percentage of students who selected the desired response on each item showed an equivalent pattern for the preformal and formal reasoners. These results suggest that specially designed instructional approaches should be used if these topics are to continue to be part of secondary science curricula. There is an indication that an ideal sequence for the teaching of concepts may exist and that this sequence should become the focus of a learning cycle model of instruction.

S6.09

COGNITIVE STYLE, ACADEMIC SELF-CONCEPTS, AND CREATIVITY AS PREDICTORS OF ACHIEVEMENTS IN SCIENCE AND MATHEMATICS

Suan Yoong, University of Science, Malaysia

This paper reports the empirical relationships between science and mathematics achievements and cognitive style, self-concepts, and creativity for a cohort of Malaysian secondary school students. Validated Malaysian versions of the psychological measures were administered to 267 Malaysian secondary four students, whose mathematics and science grades from a public examination were taken as dependent variables. Mathematics and science achievements correlated significantly with cognitive style (field independent students more likely to be high achievers) and specific academics self-concepts. Mathematics achievement correlated significantly with all 3 traits of pictorial creativity and one of verbal creativity, while science achievement correlated significantly with two traits of verbal creativity. Multiple regression analyses showed that the regression variance accounted for by the independent variables were 64% for mathematics and 59% for science, respectively. six predictors, particularly cognitive style and self-concepts in mathematics accounted for most of the regression variance

S6.09

FORMAL REASONING AND SCIENCE TEACHING

Valanides Nicolaos, University of Cyprus

Performance of 195 seventh-, eighth- and ninth-grade students on TOLT (Test of Logical Thinking) was used to identify differences related to five reasoning mode (control of variables, proportional, correctional, probabilisitic and combinatorial reasoning) among the three classes and between male and female students. The new science, does not seem to facilitate the development of students' reasoning abilities.TOLT scores showed a "delay," from the Piagetian point of view, in the development of students' reasoning abilities and only ninth-grade students had significantly better ($p<.05$) performance than only seventh-grade students and only on proportional reasoning problems, while there were no significant differences between male and female students. Multiple regression analysis showed that chronological age in months and achievement in science and mathematics, but not achievement in greek language, contributed significantly to prediction of performance on TOLT. Factor analysis based on performance on the five reasoning modes produced a one-factor solution and factor analysis based on performance on each TOLT item (two items for each reasoning mode gave a three-factor solution explaining 43.8% and 54.9% of the variance respectively.) These results indicate the need for neo-Piagetian views to explain cognitive development.

S6.10

LEARNING STYLE ANALYSIS IN A CALCULUS-BASED INTRODUCTORY PHYSICS COURSE.

Teresa L. Hein, South Dakota State University

The objective of this study was to assess the individual learning styles of students in two classes of calculus-based introductory physics. One of the goals of this case study was to use the assessments to modify instructional strategies to better suit the learning style preferences of the students enrolled in these courses. The Dunn, Dunn and Price Learning Style Inventory was administered to approximately 60 students. Results of this study indicated that approximately 65% of the students assessed had a high preference for structure in the classroom. Furthermore, 62% of the students indicated that they would learn more and better in the afternoon, even though the classes they were enrolled in met in the early morning. A significant modification in classroom strategies following the assessment was to offer examinations in the afternoon to accommodate student preferences. Moderate gains in exam scores were achieved.

S6.10

A Study of An Organizational Structure for Cooperative Work Among University Students in an Introductory Laboratory for Science and Engineering Majors *

Patrick Kenealy, Physics/Astronomy and Science Education, California State University LB, Long Beach, CA 90840-3901

During the last year, we completely revised the social structure in all sections of the introductory physics laboratories for the calculus-based sequence to allow students to share data in preliminary form, and to discuss and revise their ideas about the meaning of that data. The rationale for group work of this kind, which includes open sharing and discussion of data, and the demand for qualitative and quantitative coherence in written and spoken presentations, will be presented. In a process of formative evaluation, 3 questionnaires per semester were administered to all lab students, providing demographic data, student ratings of anxiety, interest, and confidence, a pre- and post-measurement of physics content, and student evaluations of the procedures in the laboratory. Most of this data was keyed throughout to individual student respondents, allowing us to differentiate the responses of students of different rank and different educational background.

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S6.10

ASSESSMENT OF SCIENCE MISCONCEPTIONS: STUDENT'S EXPECTATIONS AND RESEARCHER'S QUESTIONS

Rebecca J. Pollard and David M. Cole
Texas A&M University

Science misconceptions are typically elicited through the use of researcher driven questions. The present study investigates the potential mismatch between student's expectations of assessment and assessment undertaken by researcher. Results indicate that students expect more low-level text based questions than are asked during assessment. These expectations are consistent with student's prior experiences with the breadth, low-level learning in the text bound classroom. These results may be used to infer that some science misconceptions may be an artifact of assessment rather than a product of teaching and learning.

S6.10

AN INDIVIDUAL STUDENT'S LEARNING PROCESS IN ELECTRIC CIRCUITS

Hans Niedderer, University of Bremen, Germany
Fred Goldberg, San Diego State University, USA

Our learning process study with three college students focused on a microanalysis of thinking and learning during an open-ended instructional unit of electric circuits. A locally developed computer video software program using a pressure representation of potential was used to provide students with a tool to develop their own ideas in the context of predictions and explanations of experiments with batteries and bulbs. The whole process of 6 sessions was videotaped and transcribed. In this third paper dealing with the same data base the cognitive development of one student from prior conceptions (especially an everyday life view of "current") to several different intermediate conceptions ("current" seen in the new context of the concept "pressure" and a microscopic view of the electron movement) is described. The relation between instruction and learning is analyzed: In some cases we find resonance, instruction is followed by a conceptual change (microscopic view); in other cases the student does not take over instructional ideas or uses them only when prompted directly (e.g. reasoning with pressure difference).

S6.11

COLLEGE STUDENT PERFORMANCE ON THE CULTURAL LITERACY SCIENCE ASSESSMENT INSTRUMENT.

Fred H. Groves, Ava Pugh, and Peter Mangold, Northeast Louisiana University

This study was a replication and amplification of another study in which a Cultural Literacy Science Assessment (CLSA) instrument was developed. The CLSA was developed from a list of science terms drawn from Cultural Literacy: What Every American Needs to Know, by E.D. Hirsch, Jr. That study found no difference in achievement between 2 college student groups. This study tested college students by 5 different major categories and found several significant differences. Junior and senior science majors scored higher than each of the other groups. Freshmen and sophomore science majors scored higher than elementary education juniors,seniors and graduates, and liberal arts juniors and seniors scored higher than the elementary education graduates. Amount of exposure to college science courses had a significant effect on performance on the CLSA. No difference between non-science undergraduate students was found.

S6.11

USING CUE ATTENDANCE TO IMPROVE PROBLEM SOLVING ABILITIES OF FIFTH GRADE STUDENTS

Susan A. Migon, Syracuse Diocese and J. Nathan Swift, State University of New York at Oswego

The purpose of this research study was to determine if intensive instruction in cue attendance enhances students' problem solving abilities. Students in a parochial elementary school were randomly assigned to an experimental group (N = 15) which received instruction in cue attendance or a control group (N = 15). Students in the experimental group were shown a short video presentation of a physical science experiment. The students were required to recall 60 details from the video. The video was shown as many times as necessary to reach the criterion. The instrumentation used in this study was the Test of Problem Solving. Analysis of variance was used, with the pretest as the covariate. The results showed a significant difference favoring the experimental group. Therefore, it appears that intensive instruction in cue attendance improves the problem solving abilities of fifth grade science students.

S6.11

"THE SHADOW IS THERE BUT YOU CAN'T SEE IT." SHADOWS - A CONTEXT FOR DEVELOPING A LEARNING MODEL FOR SCIENCE EDUCATION OF YOUNG CHILDREN.

Gilda Segal and Mark Cosgrove, University of Technology, Sydney

As part of an investigation into developing and describing learning environments in science education for young children, we amalgamated features of cooperative learning, informal inquiry and context to construct a three part learning model. Here we report upon one study in which children (aged 7-9) were encouraged to explore shadow formation within their small group and articulate their views on it. They used resource materials, listened to ideas from group reporters and conversed in small groups with one of us. Our analysis of audio and video recordings indicates that many children enjoy engaging in intellectual discussion; many cooperatively and socially construct knowledge; most are capable of spontaneous scientific investigatory activity; a few develop new insights into shadow formation without formal instruction or attempts at conceptual change on the part of the teacher; some adapt resources and context to construct gender according to establish societal norms. We attribute many of these effects to our learning model. In discussing out observations, we try to penetrate children's reasoning, suggest some conversational probes which may assist teachers to access children's views and offer insight into ways in which children bind their group so that it offers social and emotional support to its members.

S6.11

NEURO-COGNITIVE DEVELOPMENTAL VARIATIONS FOUND RELATED TO SUCCESS IN MIDDLE SCHOOL & SCIENCE

Rita W. Peterson, University of California, Irvine

The goal of this multi-year project is to search for and understand the implications of research in the mind-brain sciences (the neuro-cognitive sciences) for educational practice. The present study examined the relationship between variations in students' neuro-cognitive development and their academic success in middle school, generally, and in science classes specifically, in the interest of exploring factors that contribute to students' failure in middle school. Using Levine's instrument, Student's View, to assess adolescents' neuro-cognitive development of attention, memory, language, visual-spatial and temporal-sequential processing, the self-assessments of 40 students, Grades 7 & 8, were compared with their academic success in middle school and science, indicated by teacher evaluations and school grades. Analysis of results suggests that students' academic success is related to self-perceptions of strengths/weaknesses in attention, memory, language, visual-spatial and temporal-sequential processing. Results of this study suggest the potential value of Levine's model of neuro-developmental variation for (1) understanding the range of variations in students' neuro-cognitive development, (2) furthering research on relationships between neuro-developmental variations and academic success, and (3) preparation of science teachers who modify science instruction to accommodate neuro-developmental variations among students in science classrooms.

S6.12

STRATEGIES EXHIBITED BY HIGH SCHOOL STUDENTS DURING BIOLOGY LABORATORIES

Laura M. Barden, The University of Tennessee, Knoxville

The focus of much of the research concerning problem solving has been on comparing the ways novices and experts solve problems. The development of students' strategies for solving problems have seldom been examined, particularly in a social setting such as the school laboratory. This study was designed to investigate the types and development of strategies exhibited during laboratory activities. Subjects included 16 high school students enrolled in a single section of Biology I. Several types of data were collected for each subject. First, lab groups were observed during lab sessions—conversations between lab partners were audiotaped and their corresponding activities were noted. Prior to each lab session, the order of observation was randomly determined. Second, six subjects were randomly selected to participate in two semi-structured interviews. The interviews were designed to focus on subjects' strategy use during lab and their level of understanding of lab content. Third, all subjects submitted responses to lab questions and lab reports. Several distinct types of strategies were exhibited. The three most common categories related to social interactions, completion of the lab tasks, and relating lab activities to theory. The type of lab performed (traditional vs. open-ended) influenced the frequency of types of strategies used.

S6.12

GOALS AND BEHAVIOR OF FOUR FEMALE STUDENTS AND THEIR TEACHER DURING PILOTING OF NGS KIDSNET UNIT, *HOW LOUD IS TOO LOUD*, IN AN 8TH GRADE "AT-RISK" CLASSROOM.

Ruth Bombaugh, Nancy Marx & Karen Mahliot, U. of Michigan

While discussing how best to train beginning researchers, Stephan J. Ball claims: "Ethnographic research probably is unteachable... the only way to get better is to do more of it" (1990, pp. 157-158). Following this dictum, we three first-year pre-candidates examined the intersubjective reality of an eighth-grade, at-risk science class as interpretive researchers. The reader can examine our work from two levels, the pedagogical aspects of learning to do research and the significance of the actual research performed. The study itself focused on the goals and behavior of four female students and their teacher in an eighth-grade classroom of "at-risk" students during the piloting of a NGS Kids Network curriculum, *How Loud is Too Loud*, a hands-on, telecommunications-enhanced science unit on sound. Students and teacher were video and audio-taped bi-weekly over three months. Conversational analysis, interview analysis, percent completeness of the students' cumulative folders, plus a setting analysis suggested the four students met the teacher's stated goals of social responsibility but did not meet the curriculum designers' goals of a deeper understanding of factors affecting sound levels, impact on the human ear and subsequent social implications .

S6.12

SCIENCE CONCEPT LEARNING BY ENGLISH AS SECOND LANGUAGE JUNIOR SECONDARY STUDENTS

Pui-Kwong Lai, Keith B. Lucas, Ed V. Burke, Queensland University of Technology, Australia

Recent Chinese migrant students from Taiwan studying science in two Australian secondary schools were found to explain the meanings of selected science concept labels in English by translating from Chinese. The research strategy involved interviewing the students concerning their recognition and comprehension of the science concept labels firstly in Chinese and then in English. Mean recognition and comprehension scores were higher in Chinese than in English, with indications that Chinese language and science knowledge learnt in Chinese deteriorated with increasing time of residence in Australia. Rudimentary signs of the students being able to switch between Chinese and English knowledge bases in science were also found. Implications for teaching science to ESL students and suggestions for further research are discussed.

S6.12

COMPARISON OF REPORTED STUDY SKILLS OF NINTH GRADE SCIENCE STUDENTS ENROLLED IN AN OUTCOME BASED EDUCATIONAL CLASSROOM AND A TRADITIONAL CLASSROOM.

Calvin O. Froehlich, Willmar High School and Jeffrey R. Pribyl, Mankato State University.

The objectives of this study were to measure the differences in reported study skill usage of ninth grade science students enrolled in an Outcome Based Educational (OBE) classroom and a traditional classroom and to investigate the correlations of reported study skill usage and success in the science course. A study skill survey was administered at the beginning and the end of the academic year to 160 students in the OBE classroom and 56 students in the traditional classroom. Results indicate usage of study skills is dependent upon the method of instruction. Also students experiencing greater level of success in the course reported higher usage of science specific study skills regardless of the educational environment.

S6.13

COGNITIVE DEMANDS OF ALTERNATIVE SCIENCE ASSESSMENTS: THEORY AND RESEARCH

Gail P. Baxter , Timothy J. Breen, Anastasia D. Elder, University of Michigan and Robert Glaser, Kalyani Raghavan, Learning Research and Development Center, University of Pittsburgh

The purpose of this study is to carry out analyses of the cognitive activity prerequisite to proficient performance on existing innovative assessments in science. Protocol analysis in conjunction with observations of students' performances, and an examination of students' answer booklets and scoring criteria provide an empirical basis for linking performance scores with level and kind of reasoning and understanding. Analysis of the detailed verbal protocols of students' performances in assessment situations in California and Connecticut were guided by general dimensions of problem solving on which more or less proficient students differ. Our purpose was to characterize the kind of performance actually elicited from students and describe how this performance differs among students at various levels of achievement. Documentation of the match or discrepancy between descriptions of behavior and the actual cognitive processes that students carry out is an important issue in the development of assessment instruments that purport to be innovative in ways that tap higher-order thinking. Results of these analyses provide the basis for a framework for designing assessments which tap the kind of cognitive skills that underlie assessment objectives.

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S7.01

TEACHERS' BELIEFS ABOUT THEMATIC SCIENCE CURRICULUM REFORM: FROM ANTICIPATION TO IMPLEMENTATION

Frank E. Crawley and Barbara Salyer Babineaux
Science Education Center
University of Texas at Austin

The purpose of this study was to describe the beliefs of four life science teachers enrolled in a retraining program, as they moved from anticipation to implementation of thematic science in their classes. This study is a follow-up to an earlier one, in which four life science teachers were interviewed, using open-ended questions. Question design was guided by the Theory of Planned Behavior. Unlike our earlier study which reported on life science teachers' beliefs as they anticipated teaching integrated rather than single-discipline science, this study reports on changes in these four teachers' beliefs after they have begun to teach thematic science. Results of our interview analysis led us to restate five assertions from our first study, to revise five others, and to propose two new assertions. Our results indicate that science curriculum reform in Texas is being jeopardized by the lack of districtwide commitment in some school districts and the willingness of other school districts to place sole responsibility on teachers for its success.

SPECIAL SESSION

S7.01

SCAFFOLDING: AN ASSET TO CHANGING TEACHER BELIEFS IN IMPLEMENTATION OF NEW SCIENCE CURRICULUM.

Robert L. Liske, Michigan State University

This study compared the implementation of a new science curriculum for poorly motivated, low achieving science students in two different schools. In one classroom, the researcher assumed the role of researcher/observer, while in the second classroom, the researcher assumed the role of participant/observer, using a scaffolding technique to further the implementation process. A case study comparison was developed to contrast the teaching styles and teacher beliefs of the two teachers and the resultant level of implementation. Results indicated that teachers of poorly motivated, low achieving science students develop specific classroom routines and methodology as a coping mechanism in dealing with this population of students. This results in a low level of acceptance of the new curriculum. However, the scaffolding technique used in one classroom enhanced the degree of implementation.

S7.02

RESEARCH AND THEORY IN THE USE OF TECHNOLOGY IN SCIENCE EDUCATION

Marcia Linn, University of California-Berkeley, and Carl F. Berger, University of Michigan

Students tend to isolate rather than integrate the science information they learn in school. For example, many students believe that objects remain in motion at school but come to rest at home. How can we SCAFFOLD knowledge integration and can technology contribute? Theories advocate activities like "reflection" and "scaffolding", but say little about how to teach for knowledge integration. Technology offers tools like microcomputer-based laboratories, data bases, and dynamic models that may reinforce isolation of science knowledge. We need a framework for curriculum design that leads to sensible and effective use of technology. Some promising directions will be proposed.

S7.01

HIGH SCHOOL SCIENCE TEACHERS AS BARRIERS TO CURRICULUM REFORM IN SCIENCE: FACT OR FICTION?

Barbara Salyer Babineaux and Frank E. Crawley
Science Education Center
University of Texas at Austin

This study was designed to explore the beliefs and actions of high school science teachers in Texas concerning the move to implement coordinated thematic science in grades 7 through 10 over the next few years. Specifically, the study sought confirming or disconfirming evidence for the prior belief expressed by middle school science teachers who are being retrained to teach CTS that high school science teachers represent a potential barrier to the survival of the secondary science reform movement in Texas. Semi-structured interviews with the teachers provided data which were used to generate assertions concerning their beliefs about the reform process. An analysis of these assertions led us to conclude that the reform process in Texas is in peril due primarily to the lack of systematic efforts at the State or district levels to communicate with the high school science teachers.

S7.03

CONCEPTION AND APPLICATION OF THE KIELER MOTIVATIONAL LEARNING CLIMATE QUESTIONNAIRE FOR CHEMISTRY INSTRUCTION AT GERMAN SCHOOLS.

Claus Bolte, Institute for Science Education, Kiel (Germany)

Contrary to the recommendations of international didactic literature, reflections on creating a positive learning atmosphere are very seldom integrated into the planning and realisation of science instruction at German schools. One of the reasons for this may be that teachers do not know enough about the results of learning climate research or if they do, that they consider the evaluation methods too unproductive. **One aim of this study was to develop a polling instrument that is highly practical, easy to handle and supplies teachers and researchers with extensive and interesting information about the motivational learning climate in their classes.** Our polling instrument was given to 1027 students and 52 teachers to research a number of issues. The data analyses show that the polling instrument is theoretically sound and practically appliable. The analyses demonstrate that teachers can gain an insight into selected aspects of their chemistry instruction with the help of the instrument. Knowledge concerning what and how the students would like to learn in chemistry instruction and how they perceive and assess this makes it possible to improve teaching effectively.

S7.03

TEAM TEACHING IN A COLLEGE LEVEL PHYSICAL SCIENCE COURSE.
Sabitra S. Brush, Armstrong State College

This study examines the teaching and learning experiences of three professors, (two from the physics department, and one from the chemistry department) who were involved in the team teaching of a restructured science course for prospective elementary teachers at the Florida State University. Because the instructors had very different personalities, as well as philosophies, team teaching became an interesting challenge for those who were involved.

S7.04

PRESERVICE BIOLOGY TEACHERS' CONCEPTIONS OF TEACHING SCIENCE: THE METAMORPHOSIS OF ONE TEACHER'S VIEWS
Perry Allen Cook, University of North Dakota

A qualitative, descriptive investigation into conceptions of teaching science held by five preservice biology teachers in a constructivist methods and practicum. This paper focuses on the developments in one teacher's views about teaching science (Gene). The study examined initial and exit conceptions of teaching science, changes in conceptions and, influences on those changes from methods and practicum. Major data sources included: two sets of Conceptions of Teaching Science interviews concerning beliefs about science, learning, instruction and effective science teaching; two sets of Influence Interviews about significant methods and practicum experiences influencing evolving views and; journals. Gene's initial views about science stressed that science was everything whereas his exit views represented a more conceptual understanding of science. Other developments included a newfound view of the role that probing learners' prior knowledge of content plays in the learning process and a growing view that a constructivist perspective and conceptual change model offered a useful approach to science teaching. The results suggest important changes did occur in preservice biology teachers' conceptions of teaching science enrolled in a constructivist methods and practicum.

S7.03

TEACHING OF A LARGE SCIENCE CLASS : A CASE STUDY AT UNIVERSITY OF DURBAN WESTVILLE - SOUTH AFRICA
Prem Naidoo and Shakila Reddy, University of Durban-Westville

In this paper the researchers "describe" and "illuminate" the problems of teaching a large class (156 students) of first year science student teachers at university in a developing country. The central problem that the lecturer (one of the researchers) had to overcome was of lecturer domination so as to encourage student-centred learning. A cooperative learning approach was adopted by the lecturer, in order to address the stated problem. Although, being informed by the theoretical foundation and other research data on cooperative learning, the implementation of the innovation of cooperative learning by the lecturer was initially a failure. However, when the implementation was attempted in conjunction with action research, significant successes were noted. Within this context the researchers evaluate the successes and failures of :
i) cooperative learning as a means of teaching a large class.
ii) the relationship of action research to implementing an innovation.
Drawing from this case study, the paper will raise some questions and implications for the theory and practice of cooperative learning in the teaching of large classes in developing countries.

S7.04

CONCERNING THE DISPARITY BETWEEN INTENTION AND ACTION IN THE TEACHING OF PHYSICS
Helmut Fischler, Freie Universität Berlin, Germany

It is plausible to assume that teachers' thoughts and actions depend very strongly on the teaching subjects which they have studied and are teaching in school. For science teachers there are presumably the following subject related variables which have an important influence: Conceptions of the nature of science, of teaching science and of learning science. The research project to be described focuses on the connection between these conceptions and characteristic features of physics teachers' decision-making during the teaching process. Do such connections exist at all, or do completely different factors play a more important role in the concrete teaching-learning process? The results of my investigations demonstrate relatively clear tendencies. Especially teachers without extensive teaching experience are dominated by orientations of actions that follow above all external criteria for a successful teaching process: "Activity-flow orientation" and "completion orientation". Together with an "offer-reception orientation" for teaching-learning processes these orientations promote teachers' behaviour which gives the students few possibilities for learning on their own.

S7.04

INVESTIGATING PRESERVICE CHEMISTRY TEACHERS' THOUGHTS IN MICROTEACHING CONTEXT--CASE STUDIES.
Hsiao-lin Tuan and Shung-lin Fong, National Changhua University of Education, Taiwan, R.O.C.

Microteaching experience is the first step for preservice teachers to integrate into practice what they have learned in their preparation program. It is very important, therefore, for science educators to understand what these teachers learn from microteaching. The practicum course in Changhua requires preservice chemistry teachers to prepare two twenty to thirty minutes of microteaching lessons. Semi-structured interview protocols as well as other informal interviews were used with two of these teachers to obtain information on their views on teacher education programs, microteaching, and science teaching and learning in general. Also all the students' teaching performances were video-taped and analyzed, and other data resources included self-analysis sheets, peer coaches' comments, and field observation notes. The data showed that the two preservice teachers' thoughts were concerned with content arrangement and concept expression in planning, and that these concerns were influenced by three factors: views of science teaching and learning, context problems, and personal characteristics. The paper concludes by discussing benefits and limitations of microteaching.

S7.05

MEASURING PRE-SERVICE SCIENCE TEACHERS WITH THE MODIFIED NATURE OF SCIENCE SCALE
William J. Boone, Indiana University

This study presents the results of surveying over 130 pre-service science teachers using the Modified Nature of Science Scale. The 40 items were rated using a 6 step scale of strongly agree, agree, barely agree, barely disagree, disagree, and strongly disagree. Results indicate a wide range of student responses, however, a clear ordering of items is revealed even when measurement error is considered. Most items were rated by the students, on average, utilizing one of the three agree options. Results of the study indicate that this scale is helpful in defining the views of pre-service teachers toward science. Analysis also suggests that some items on the scale may need to be revised, although overall the survey seems to do an excellent job of defining the nature of science variable.

S7.04

A STUDY OF THE PREPARATION OF PRESERVICE MIDDLE SCHOOL SCIENCE TEACHERS. EXPLORING ATTITIUDES AND ANXIETIES
Robyn L. Wertheim & Scott B. Watson. East Carolina University

The purposes of this study were: (1) to record attitude and anxiety levels of preservice middle school teachers working toward certification in science as a primary area (27 or more semester hours of science) and those who have chosen science as an equal or secondary concentration (24 semester hours or less of science): and. (2) to determine the effect of the amount of required science coursework on attitude and anxiety levels and the implications thereof. A causal comparative research design was utilized for this study The independent variable was the amount of science coursework required of students . Dependent variables were results from the Revised Science Attitude Scale (Thompson & Shrigley. 1986) and the State-Trait Anxiety Instrument-Form Y (Spielberger. Gorsuch. & Lushene. 1970). Directional hypotheses stated that preservice middle grades students in programs that require greater amounts of coursework in science content will have both a more favorable attitude and lower anxiety level toward science. For data analysis. t-tests were utilized to compare the two major groups in terms of attitude and anxiety. Significant differences were found between the groups in their attitude and anxiety levels. and these differences were in the hypothesized direction

S7.05

TEACHERS' VIEWS OF THE ROLE OF EVOLUTION IN THE STRUCTURE OF BIOLOGY.
Julie Gess-Newsome, University of Utah

National biology reforms often define evolution as the unifying concept in biology. However, few inservice teachers have such an understanding of this role. The purpose of this study was to evaluate the effectiveness of a course sequence in evolution designed for inservice biology teachers on their conceptions of the role of evolution in the field of biology. Twenty-two teachers attended a two-quarter course sequence which covered the history and mechanics of evolutionary theory, and included a 12-day field trip to the Galapagos Islands, and a subsequent synthesis of course materials into classroom lesson plans. Teachers' views of the role of evolution in biology did not change as a result of the program. Less than 50% of the teachers even included evolution in their description of biology, with only two teachers recognizing the unifying role of biology. However, when asked specifically about the structure of evolution, 50% stated that it was a unifying theme. Despite course work specifically on evolution content and its unifying role in biology, it seems that teachers are unable to break away from traditionally fragmented views of biology content.

S7.05

PRESERVICE TEACHERS' VIEWS OF THE NATURE OF SCIENCE DURING A POSTBACCALAUREATE SCIENCE TEACHING PROGRAM

Bruce C. Palmquist, Central Washington University and Fred N. Finley, University of Minnesota

The goals of this study were to determine preservice science teachers' views of the nature of science and to describe the changes in those views that occur during a teacher education program. Fifteen students in a postbaccalaureate science teaching program at a large university participated in this study. The participants' views of science were ascertained by an author-developed survey and a follow-up interview administered before and after the university's science teaching methods sequence. Before entering the teaching program, the participants had a contemporary view of scientific theory, knowledge and the role of a scientist and a traditional view of scientific method. Initially, there was an equal number of traditional, mixed and contemporary views of the different aspects of science. After completing the methods sequence, the number of contemporary views doubled and the number of mixed views decreased by more than half. The number of participants with an overall, contemporary view of science rose from two to seven. Since there was little instruction about the nature of science, it is possible to make positive changes in preservice teachers' views of the nature of science in a teaching program where contemporary teaching strategies such as conceptual change and cooperative learning are taught.

S7.06

LISTENING TO OTHER VOICES: ADDING COGENCY TO SCIENCE EDUCATION RESEARCH BY BROADENING THE THEORETICAL DIALOGUE.

William G. Holliday and J. Randy McGinnis, University of Maryland at College Park, and Rebecca Pollard, Texas A&M

This symposium uses an experimental, innovative triple-session format to advocate the consideration of theoretical perspectives that are currently being productively used by researchers in fields typically not referenced in mainstream science education literature. The theme of the session will be adding cogency to our arguments in science education research by incorporating alternative conceptual systems in planning and implementing research studies. Participants in the session, in small groups, will rotate through three strands heuristically identified as Other Voices One, Two, and Three. Each strand will be conducted by a symposium panel member. These strands will present theoretical perspectives guiding research practitioners in three separate fields under-represented in science education literature: self-regulating engaging strategies, performance arts, and transcending qualitative-quantiative perspectives. The symposium panel members will use research study vignettes and meet-the-researcher through direct readings of e-mail communication and transcribed interviews.

S7.07

FACTORS RELATED TO SCIENCE FAIR SUCCESS

Andrew T. Lumpe and Charlene M. Czerniak, University of Toledo

The researcher's focus was to: 1) ascertain students' perceptions about the advantages and disadvantages for science fair participation; 2) describe students' perceptions about who might approve and disapprove of science fair participation; and 3) determine the relationship of certain internal and external factors to science fair success. Students listed learning, improving one's grade, and receiving money as advantages and wasted time and hard work as disadvantages. Parents and teachers were listed by many students as approving of science fair participation. Using regression modeling, only parental education significantly predicted a portion of the variance in students' science fair scores (N=302). Factors not related included attitude toward the science fair, subjective norm, anxiety, GPA, gender, age, school type (public or private), and requirements by teachers to participate.

S7.07

INFLUENCES ON SCIENCE FAIR PARTICIPANT RESEARCH DESIGN SELECTION AND SUCCESS.

Eric J. Pyle, The University of Georgia.

The basic purpose of this investigation is to gain a better understanding of the characteristics of pre-college researchers, by examining the influences on research design selection and success of International Science and Engineering Fair finalists. The 22 participants completed a survey describing the influences on their research activities and methodologies. Further data were collected from artifacts collected from the participants and the Science Service. Data were analyzed using an interpretive methodology. Of the sample group, 9 received at least one award and were classified as "winners". While research design selection was not found to directly affect success, winners were less consistent in identifying their actual research designs but more systematic in the utilization of available resources. In addition, winners relied on the strength of their research methods, while non-winners relied on the general quality of their work for success. Participants in general had met with limited success with non-experimental research designs at previous competitions. Distinctions between winners and non-winners can be made by the consistency of resource utilization and a closer focus on methodology and research outcome by successful participants.

S7.07

FROM AN ARISTOTELIAN TO A NEWTONIAN WORLDVIEW: AN INTERACTIVE COMPUTER-BASED MICROWORLD AS A MEDIATIONAL TOOL FOR THE SOCIAL CONSTRUCTION OF SCIENTIFIC CONCEPTS IN HIGH SCHOOL PHYSICS

Gilian Smith, Wolff-Michael Roth, and Carolyn Woszczyna, Simon Fraser University

Using activity structures which combined the affordances of an interactive software program (a physical microworld) and new conversational structures (student-student science talk rather than didactic interactions), we supported a variety of student actions on symbolic representations and conversations about them and their meanings as Grade 11 students manipulated and observed multiple representations of objects in a microworld. In this context, conceptual change has to be described as cumulative and incremental rather than as discrete and radical. The computer microworld facilitated social interactions and joint sense-making in many respects but also created barriers to learning which can be linked to technological and physical limitations of the technology.

S7.08

GUIA GENERAL PARA LA IMPLEMENTACION INICIAL DE CARRERAS COPUTACIONALES EN AMERICA LATINA

Ramón Mata-Toledo, Carols A. Reyes-García, y Raúl A. Sánchez-Guerrero, James Madison University, Virginia, Instituto Tecnológico de Apizaco, Mexico y Universidad Nacional Experimental del Táchira, Venezuela

A medida que nos acercamos al siglo XXI, el sistema educativo de los paises industrializados, por razones económicas, polltlcas y sociales, está experimentando una verdadera revolución que refleja el cambio de esas sociedades hacia la "era de la informática". Contrario a esta realidad los países del tercer mundo, y en particular los países latinoamericanos, es ahora cuando se están incorporando a la revolución tecnológica que tuvo comienzo a finales de la década de los años setenta. Esta situación, aunque parezca desfavorable, ofrece ciertas ventajas pues permite a los responsables de las políticas educativas nacionales aprender de los errores que las sociedades más avanzadas han cometido en cuanto a la estructura y el contenido programático que sería necesario impartir para obtener equiparidad con los países a la vanguardia de la revolución tecnológica. Este artículo tiene como finalidad identificar aquellas tecnologías, cursos y nociones fundamentales que puedan producir el mayor impacto en la enseñanza y el aprendizaje y en particular en las carreras computacionales que, al fin y al cabo, sirven de soporte fundamental al motor de la tecnología moderna, el computador.

S7.08

LA UTILIZACIÓN DE LA HERRAMIENTA DE LOS HIPERTEXTOS EN EL DESARROLLO DE SOPORTES DIDÁCTICOS COMPUTACIONALES PARA LA ENSENANZA DE LAS CIENCIAS

Luciano Barragan, Universidad Central de Venezuela, Venezuela

La enseñanza asistida por computador (E.A.C.). Existen muchas definiciones e interpretaciones de la enseñanza asistida por computador (E.A.C.) pero la más profunda por su implicación es la que se cita a continuación. (Zam-92): "La E.A.C. hace referencia a la utilización interactiva del computador como herramienta pedagógica en el centro de una relación educativa entre alumnos y docentes". Esta interpretación menciona la palabra computador en el sentido de sistema de computación. Cualquier tipo de sistema de computación está compuesto necesariamente de "hardware" (computadores, terminales, periféricos, etc.) y "software" (sistemas operativos, aplicaciones, programas, etc.), y la E. A. C. no se escapa a esta regla.

S7.08

DESARROLLO DE HABILIDADES BASICAS EN MATEMATICAS PARA COMPUTACION: UNA EXPERIENCIA EN CENIDET

J.L. Ramirez, Manuel Juarez, y Luis Villalobos, Centro Nacional de Investigación y Desarrollo Tecnológico, Mexico

En este trabajo se expone la problemática del CENIDET en cuanto a la formación matemática de sus estudiantes en la maestría de ciencias de la computación. Las principales deficiencias detectadas en el área de atemáticas de los estudiantes que desean ingresar a la maestría son: insuficiente dominio de los conceptos principales de cálculo, deficienciasen la construcción de modelos matemáticos a partir de situaciones reales, carencia de habilidades para la lectura y comprensión del texto matemático y deficiencia en las estrategias para la solución de problemas.

S7.08

ESTRUCTURA MODULAR DE UN SISTEMA TUTORIAL INTELIGENTE PARA LA ENSENANZA DE DISCIPLINAS TEORICAS Y PRACTICAS
Faisal Zeidan, Universidad de Los Andes, Venezuela

El presente estudio es un enfoque general a un sistema tutorial inteligente para la enseñanza de asignaturas que requiere conocimiento cognitivo y habilidades físicas. Este sistema tutorial inteligente para la enseñanza de disciplinas teórico-prácticas incorpora técnicas de inteligencia artificial para mejorar el entrenamiento y las habilidades de aprendizaje.

MONDAY -- MORNING

M2.01

TEACHERS' PERCEPTIONS OF TOPICS SELECTED BY BOYS AND GIRLS FOR SCIENCE FAIR PROJECTS
Eileen D. Bunderson and J. Hugh Baird
Brigham Young University

In most classrooms, students have little control over science topics included in the curriculum. However, teachers' perceptions of students' preference for science and science topics may influence what knowledge and processes teachers promote, and what experiences students have in the classroom. Science fairs have allowed students an opportunity to demonstrate a preference for certain science topics over others. Science fair choices of over 2300 students were matched with teachers' perceptions of science fair topics thought most likely to be chosen by the students. Topics were ranked in order of preference and rankings of students and teachers compared using the Spearman rank-order correlation (rho). Teachers' perceptions of what topics students chose for science fair projects seldom matched choices made by the students. Teachers' perceptions reflected more gender stereotyped views of science, and assumed more gender-based diversity in students' choice of topics.

GENERAL SESSION

S8.15

"STRONG OBJECTIVITY": IMPLICATIONS FOR SCIENCE EDUCATION RESEARCH
Sandra Harding, University of Delaware and UCLA

Are the standards for maximizing objectivity in the sciences comprehensive enough? Are prevailing research methods powerful enough to achieve such goals? Few would challenge the fact that not just individual biases but also widespread historically changing cultural assumptions have shaped modern scientific problematics, research designs, interpretations of data, results of research and, consequently, the picture of nature's regularities and their underlying causes held both by scientists and the public. Many scientist and science observers now argue not for weaker or "different" standards and methods for resolving the "objectivity question", but for stronger ones. The gender and postcolonial analyses provide useful resources for such a project. What implications does the program for "strong objectivity" have for science education research?

M2.01

PREPARING GENDER-SENSITIVE SCIENCE TEACHERS.
Kate Scantlebury, University of Delaware

This study presents a likely story of a preservice secondary science teacher's university experiences to argue for changes in science teacher education. The concepts "gender-sensitive," "gender-free" and "gender-laden" are defined and used in a discussion of the how gender is ignored and denied by preservice teachers and educato The likely story provides an example of the educational experiences of one preservice teacher and how those experiences influenced her belief that education should be gender-free. Science educators need to provide educational experiences for preservice teachers that will help them recognize that presently education is "gender-laden" For changes to occur in girls' education in schools what is needed is for preservice teachers to experience and understand the importance of a "gender-sensitive" education.

M2.02

A CONCEPTUAL CHANGE RATIONALE FOR THE DESIGN OF BIOMAP: AN INTERACTIVE HYPERMEDIA ENVIRONMENT TO PROMOTE CONCEPTUAL UNDERSTANDING IN BIOLOGY

Sharolyn Belzer, University of Michigan

BioMap was designed to meet the criteria for conceptual change while providing necessary scaffolding to promote understanding of evolution and natural selection. In a preliminary study on undergraduate non-science majors, students performed significantly better on the post-test than on the pre-test ($F=60.4$, $p<.0001$). While learning was significant, more than 50% of all students resisted changing five of nine major conceptual problems. Observations of students using BioMap informed the redesign process. The BioMap environment is intended to interact with student prior knowledge; support navigation, learning and conceptual restructuring; and motivate students to acquire more in-depth knowledge. A second study with undergraduate non-science majors will optimize student learning by (1) encouraging students to use BioMap more interactively and (2) administering strategy and content surveys periodically so that students ponder what and how they are learning. This paper will focus on my rationale for content, learning task, guidance and instructional design changes that I elected to make between the preliminary study and the Fall intervention, and the impact these changes have on students' understanding, patterns of conceptual change, and use of BioMap.

M2.02

STUDENTS DESIGNING HYPERMEDIA INSTRUCTIONAL MATERIALS AS A MEANS TO BECOMING BETTER LEARNERS

Michele Wisnudel and Jeff Spitulnik, University of Michigan

The use of hypermedia technology in science classrooms has great potential for enhancing both subject matter understanding as well as cognitive and social skill development. The theoretical rationale for students designing and constructing instructional hypermedia artifacts in chemistry classrooms is examined with a focus on motivational issues, the use of cognitive strategies in instructional design activities, and the resulting chemistry concept development of high school students. Eighty-eight high school chemistry students in the 1992-1993 school year were instructed in instructional design principles as they constructed hypermedia artifacts. Pairs of students created hypermedia instruction to teach their peers about the chemistry of an element of their choice. The hypermedia constructions were evaluated to determine the effects the project had on students' understanding of chemistry concepts as well as their cognitive skill development. Results indicate students effectively incorporate instructional design elements into hypermedia artifacts as well as present multiple representations and make connections between related concepts. The complexity of the artifacts and the use of instructional design principles indicate that such activities contribute to students' robust concept development.

M2.02

STAR: A HYPERMEDIA KNOWLEDGEBASE FOR SCIENCE TEACHING AND REFORM

Joanne Striley & Gail Richmond, Michigan State University

The STAR is a prototype hypermedia knowledgebase for Science Teaching and Reform. The aim of the knowledgebase is to provide prospective elementary and secondary teachers with effective models of teaching science for understanding. The components of the teaching models are: unit plans containing learning objectives, classroom activities and assessment activities; videotaped and annotated demonstrations of laboratory skills and equipment used in the activities; and most importantly, videotaped and annotated classroom practice, showing the unit being taught by an experienced teacher in an actual classroom. The model components are flexibly interlinked in a computer-based hypermedia system. We have studied prospective elementary and secondary teachers interacting with this system in teacher education classes. This formative evaluation study sheds light on how to capture and represent "expert models" of teaching practice for use with preservice teachers.

M2.03

NEGOTIATING UNDERSTANDING IN A HETEROGENEOUS HIGH SCHOOL BIOLOGY CLASS: THE STORIES OF THREE SPECIAL EDUCATION STUDENTS

Marcia K. Fetters, Michigan State University; Larry Burgess, Holt High School

This study tells the stories of three special education students in a heterogenous high school biology class. These stories focus on the role of student negotiation with science content and the classroom science community. Within this process of negotiation we explore the following questions: *What are the conditions, characteristics and limitations which affect a special education student's ability to negotiate their roles in a school science community ? What are the implications for student engagement in the class? What are the implications for developing scientific understanding?* These case studies illustrate the difficulty that arise when students learn science in mixed ability classes. As these cases illustrate there are still many barriers to acheiving the goal of true scientific literacy for *all* students.

This study takes place in a heterogeneous tenth grade biology class. Three special education students were included in a class of 24 students. This class was taught by a high school biology teacher, with assistance of a science education doctoral student. The class was taught using a conceptual change model of instruction.

M2.03

ARE WE SMART ENOUGH TO LEARN SCIENCE?
Sunethra Karunaratne and Diana I. Marinez, Michigan State University

This study investigated the influence family and community cultures on the teaching and learning of science in an after school program. The Family Science Project provided an environment for third and fourth graders to learn science with parents, adults and middle school students. The middle-school students called "Junior Scientists" assisted elementary children and at the same time learned science with them and with the adults. The participants.(20) were interviewed at the beginning of the program and at the end of one year. All the Family Science sessions were observed by the researcher taking descriptive field notes. Students' and parents' logs were also collected. Results indicated that self-esteem of children as well as their parents had gone up and developed good habits of mind. The assistance given by "Junior Scientists," and wearing white lab coats provided a conducive environment for younger children to learn science and a positive image of themselves as "scientists." The interaction with the younger children had helped develop a positive attitude toward science and meaningful science skills can be imparted in a non formal environment. The parents who participated believed that this intervention helped to direct children to being more attentive in their science and math.

M2.03

SCHOOL SCIENCE: BEYOND BLIND FAITH?
Kenneth Tobin, Florida State University and Campbell McRobbie, Queensland University of Technology.

The study employed an interpretive methodology of two teachers, a physics class, and a chemistry class. Although the teachers differed from one another in the way tney thought about teaching and learning, and even though the classes looked quite different from o ne another, both classes emphasized memorization of facts and algorithms for getting correct answers. Prior knowledge of students did not seem to be taken into account in the learning process, either by students or by teachers. Instead, science knowledge had a stamp of approval and was accepted as true without question, even if the knowledge was counter-intuitive. In both classes teachers and students were disempowered with respect to the "voice" of science. Students were not given the chance to test the viability of knowledge claims. Instead, teachers and students accepted science knowledge on faith and set aside their own intuitions without question. Whereas there are few of us that would accept this as what we want school science to be like, there are also few who are prepared to tackle this issue that is inextricably linked with a world culture that focuses on achievement on tests rather than understanding, and content coverage at the expense of learning.

M2.03

HIGH SCHOOL STUDENTS' CONCEPTIONS OF THE NATURE OF SCIENCE.
Elaine Oren, Michigan State University.

The purpose of this research is to delineate patterns in students' conceptions of the duties and goals of professional scientists compared to their own responsibilities and desires as students in a science classroom. The data consist of interviews with tenth-grade biology students near the end of a semester course in introductory biology. The interviews were examined for conceptions of *objectivity* and *isolation and community* in scientific practice and thought. The notion of *curiosity* emerged as a vital aspect of the work of scientists. The results indicate that students bring to their interpretations of science a complex of stereotypical, idealistic, optimistic, and personalized visions. They consider social and school representations of science in their constructions, but they do not uncritically accept a naive version of the "typical scientist" or of the purposes of science in society. The distinction these students make between professional science and school science is that scientists work to discover and create, while students are expected to learn what has already been discovered and created. This possibly necessary difference may disallow many students from experiencing authentic and personally useful learning in the classroom.

M2.03

PERMEABILITY OF STUDENTS' WORLD VIEWS TO THEIR SCHOOL VIEWS

Bruce G. Waldrip and Peter C.S. Taylor
Curtin University of Technology

The purpose of this study was to examine in a developing country context: (a) the traditional world view explanations of natural phenomena held by parents and students; (b) their school view explanations of natural phenomena; and (c) what interactions exist between the traditional and school views. This study builds on past research by examining the permeability of students' world views to the official Western school views. This ethnographic study involved interview and case study techniques with six village elders and 15 high school siblings in a South Pacific country. Ongoing analysis of the preliminary data reveal that both parents and students hold similar world views about natural phenomena. This study is important in that it shows that world views can be largely impervious to school views. Adaptation of the traditional world view was found to be due to the perceived material advantage to be gained from adopting the school view.

M2.03

SHIFTING SANDS: RENEGOTIATING THE DISCOURSE OF LOWER TRACK HIGH SCHOOL STUDENTS.

Randy Yerrick, East Carolina University.

The purpose of this study was to examine how shifts in standard classroom discourse patterns would be understood by lower track science students. The researcher videotaped his daily efforts to re negotiate the classroom environment to that more representative of a scientific community. This is paper is an analysis of the implicit obstacles inherent to shifting class discussions to classroom arguments examining tentative hypotheses. Discourse analysis of the arguments indicated that students have inserted struggles for social status into classroom arguments about scientific ideas.

M2.04

IMPLEMENTING AND ASSESSING INTEGRATED SCIENCE AND MATHEMATICS CURRICULA: REPORTS FROM TWO STATES

Laura N. Rogers, North Carolina State University; Vickie M. Williamson, Illinois State University; Susan L. Westbrook, North Carolina State University; and Robert L. Fisher, Illinois State University.

Two papers are presented. The first paper reports a study designed to help teachers (a) use curriculum and pedagogy that more adequately reflect the needs of their students, (b) develop curriculum to move out of the textbook and into the laboratory, and (c) assist students to develop a "habit of mind" characterized by positing thoughtful questions, engaging in conceptual reflection, and generating and testing hypotheses. Project results support the contention that teachers benefit from their involvement in the development and implementation of curricular materials. The second paper reports a formative evaluation of the Integrated Mathematics, Science, and Technology (IMaST) program for seventh grade students. A total of 512 students from five states attended three periods of IMaST each day in place of traditional classes. Student attitudes, understandings, and problem-solving abilities, along with the perceived degree of "integration" were investigated. Findings are positive; IMaST students do make connections between the disciplines. Information from this evaluation will be used for the revisions to be made prior to the scheduled Field Testing in twenty additional schools during the 1994-1995 school year.

M2.05

INCREASING THE BREADTH AND DEPTH OF RESEARCH IN SCIENCE TEACHER EDUCATION

Thomas M. Dana , Vincent N. Lunetta, Penn State Univ. & Panel

Problems and issues in science teacher education are complex, and meaningful progress will be more probable when science teacher education policy and practices are informed by rigorous and relevant research and scholarship. This symposium will promote dialogue about important scholarly questions that should be addressed in science teacher education research. Reform issues such as policy, equity, diversity, national standards, certification, ethics, supervision, and school-university partnerships, are very visible in the contemporary education literature and have implications for science teacher education research. Research in the cognitive sciences has suggested that learning is a constructive process. Reform of science teacher education delivery systems and institutions is implicit in Holmes Group and NCATE initiatives and in the gulf that continues to separate many in the science and science education communities. A central question guiding the discussion of this symposium shall be: How can these concerns and perspectives be studied and applied in research on the education of teachers of science? The panel includes individuals in the science education research community with special expertise in elements of research, science teacher education, and academic administration. Each will present a brief position statement outlining perspectives on research needs, opportunities, and resources in science teacher education research.

M2.06

SYSTEMATIC REFLECTIVE TEACHER RESEARCH IN EDUCATIONAL REFORM IN SCIENCE.

Mary Jo McGee-Brown, The University of Georgia
Mary Ann Brearton, American Assoc. for the Advancement of Science
Bernard Farges, San Francisco School District
Danine Ezell, San Diego School District

The purpose of this study was twofold: 1) to understand from multiple perspectives the development, implementation and impact of systematic reflective teacher research in a national reform effort in science literacy; and 2) to enhance teacher collaboration and sharing of teacher research findings from science contexts. The collaborative model which underpins this teacher research and the interpretive inquiry workshops will be discussed. Approximately 25 educators at each of six sites participated in interactive workshops to learn and practice teacher research methods such as interviews, questionnaires, participant observation, documents, and logs. Educator data include systematic reflections of teacher research workshops, understandings of science concepts, Project 2061 science teaching reform and resulting professional development, and different roles of systematic reflective teacher research in science teaching. Teachers engaging in systematic reflective inquiry report that it becomes an integral part of their teaching-learning process. Student data include perceptions of various aspects of science, understandings of science concepts, questions about science, and reflections on science learning.

M2.07

IMPACTING THE CLASSROOM: ASSESSING THE IMPACT OF AN ENHANCEMENT IN ELEMENTARY SCHOOL SCIENCE WORKSHOP ON PRACTICE

Bruce E. Perry, Miami University

To assess the impact of a three-week summer workshop promoting elementary science teaching as an inquiry oriented, content-rich, and socially relevant activity on the classroom environment, participants completed the Individualized Classroom Environment Questionnaire (ICEQ) (Fraser, 1989) at the beginning and the end of the workshop, and after returning to the classroom. The results show that there was a significant difference ($p > 0.01$) between the means for all scales when comparing the means reported from the Pre-Workshop ICEQ with the Post-Workshop ICEQ, that three of the scales showed a significant difference when comparing the Post-Workshop ICEQ with the mean response on the Delay Post-Workshop ICEQ, and that three other scales showed a significant difference when the means for the Pre-Workshop ICEQ were compared with the means for the Delay Post-Workshop ICEQ. The importance of these results is that there were significant changes in the perceptions of the participants as a result of their participation in a summer enhancement workshop and that these changes in perceptions of the learning environment remained in effect as they went back to their classrooms in the fall.

M2.07

EFFECTS OF A METEOROLOGY INSERVICE PROGRAM ON TEACHERS' BELIEFS AND BEHAVIORS

Thomas R. Koballa, Jr. and Eric J. Pyle, University of Georgia

The goals of the study were to document the reactions of participants (n=8) to a three-week summer inservice course and to assess the impact of the course on the participants' beliefs about teaching meteorology and their meteorology teaching behaviors. Data for the study consisted of (1) videotapes of teachers teaching meteorology to their students and interacting with colleagues about the information learned during the summer course, (2) fieldnotes complied by researchers, (3) artifacts from the participants' classrooms, and (4) an end of course questionnaire. An interpretative research methodology was used to analyze the data. Results indicated that the inservice experience was successful in improving the teachers' understandings of basic meteorological concepts and caused them to analyze their beliefs about the role of meteorology instruction. But, the culture of the school in which the participants work affected their attempts to implement their beliefs. The alignment between teachers' beliefs and their teaching behavior was aided by the collegial support provided by the participation of two or more teachers from a single school.

M2.07

USING QUALITATIVE AND QUANTITATIVE DATA TO INTERPRET THE IMPACT OF A LONGITUDINAL ELEMENTARY SCIENCE IMPROVEMENT PROJECT

J. Nathan Swift, Suzanne Weber, Barbara Beyerbach, C. Thomas Gooding, and P. R. Swift, State University of New York at Oswego

The Project SMART "Kids at Work" program is an innovative model designed to improve school science and mathematics instruction utilizing the cooperative resources of industry and higher education. This study utilized participant observation, and student interviews, and a broad scale assessment in 70 classrooms to access the effectiveness of the program. It was found that the improved attitudes observed in the two classrooms was supported by the large scale attitude survey administered to all fourth grade students in the county. It appears that teacher teams supported by content specialists from business, industry, and the university, who are brought together to develop the "Kids at Work" units, can have a positive impact on children's attitudes towards science and its usefulness in everyday life.

M2.08

COMO UTILIZAR LA HISTORIA DE LA MATEMATICA EN UNA CLASE A NIVEL MEDIO SOBRE NUMEROS IRRACIONALES

Egberto Agard, Universidad de Panamá, Panamá

El presente trabajo tiene como objetivo proporcionar al profesor de matemática de nivel medio ideas de cómo, con el apoyo de la Historia de la Matemática, el docente puede diseñar situacionesé didácticas que le permitan desarrollar con éxito algunos tópicos en ese nivel. Se presenta el caso específico de raíz de dos como primer número irracional: iniciamos con las aproximaciones obtenidas mediante el uso del algoritmo babilónico y ciertos resultados de la investigación cognitiva sobre este tópico. Finalmente se formulan algunas recomendaciones al profesor relativas a las consecuencias del tema.

M2.08

INDUCCION MATEMATICA: RAZONAMIENTO PLAUSIBLE

Guadalupe de Castillo, y Jorge Hernández, Universidad de Panamá, Panamá

En el presente trabajo se resalta la importancia del proceso de observación que lleva a una conjetura (razonamiento plausible), en la enseñanza del Principio de Inducción Matemática como método de demostración. Se aplica una prueba a una muestra de estudiantes universitarios de matemática la que corrobora la existencia de dificultades en la construcción de las conjeturas que se desean validar por el Principio de Inducción Matemática.

M2.08

PRECONCEPCIONES Y SUS RELACIONES ANTE SITUACIONES EXPERIMENTALES SOBRE CONCEPTOS DE PRESION Y FLOTACION

M. H. Covarrubias, C. F. Flores, C. L. Gallegos, M. E. Vega, G. M. Rosas, y T. D. Hernández, Universidad Nacional Autónoma de México, México

En esta investigación se analizan las preconcepciones de estudiantes del nivel medio superior existentes sobre los conceptos de presión y flotación ante dos situaciones experimentales. La muestra analizada pertenece a 10 planteles del sistema de educación media superior de la Universidad Nacional Autónoma de México. De entre ellas siete con el curriculum de Escuela Nacional Preparatoria y tres con el curriculum del Colegio de Ciencias y Humanidades. La muestra de 300 estudiantes fue elegida de acuerdo a su rendimiento escolar (alto y bajo), a los que les fue aplicado un cuestionario con 14 reactivos sobre presión y flotación de los cuales 7 están relacionados con dos actividades experimentales. De dicha muestra se seleccionaron 30 estudiantes quienes fueron entrevistados ante un problema experimental. A partir de un análisis categorial se determinan preconcepciones que son precisadas con las entrevistas y se analiza è que papel tienen en las explicaciones ante una situación experimental. En particular se determinan las formas de inferencia e interpretación de lo observado en función de las preconcepciones encontradas.

M2.08

CONSTRICTORES CONCEPTUALES Y PROCESOS DE RAZONAMIENTO

C. F. Flores, M. H. Covarrubias, C. L. Gallegos, M. E. Vega, G. M. Rosas, y T. D. Hernández, Universidad Nacional Autónoma de México, México

Se identifican en las ideas de estudiantes de nivel medio superior las preconcepciones y aspectos metalógicos que regulan el razonamiento de los estudiantes en función de generar una interpretación de los fenómenos físicos. La muestra analizada, pertenece a 10 planteles del sistema de educación media superior de la Universidad Nacional Autónoma de México. De entre ellas siete con el curriculum de la Escuela Nacional Preparatoria y tres con el curriculum del Colegio de Ciencias y Humanidades. La muestra de 300 estudiantes fue elegida de acuerdo a su rendimiento escolar (alto y bajo), a los que les fue aplicado un cuestionario con 14 reactivos sobre presión y flotación. De un análisis categorial es posible establecer relaciones entre los conceptos constrictores y sus estrategias metalógicas como elementos reguladores del pensamiento.

M2.09

SCIENCE TEACHING SELF-EFFICACY BELIEFS: RECENT STUDIES AND SUGGESTIONS FOR FUTURE RESEARCH.
Larry Enochs, University of Wisconsin - Milwaukee
Iris M. Riggs, California State University - San Bernardino
Linda Ramey-Gassert, Kansas State University
Margaret G. Shroyer, Kansas State University

This symposium focuses on science teacher self-efficacy beliefs research. Four papers will address the following topics: construct definition, measurement and past research; science teaching self-efficacy development in a teacher enhancement context; qualitative assessment and validation of the self-efficacy construct in a teacher preparation setting; and the development of self-efficacy in an innovative teacher preparation program and emerging research questions.

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M2.10

CHILDREN'S MENTAL MODELS ABOUT STARS.
Mei-Hung Chiu, Shueh-Chin Weng, and Ing-Shyan Chern, Graduate Institute of Science Education, National Taiwan Normal University.

This paper presents the results of an empirical study which investigated fourth and seventh graders' conceptual knowledge about the stars and the relationships among the stars, moon, sun, and earth. About ninety students of each grade were asked to answer a series of open-ended questions about the sizes, shapes, components, and movement of the stars. Thirty students were drawn from each grade and then individually interviewed by the researchers to further confirm their responses to the questions. All interviews were videotaped for later transcription and analysis. There are four major findings. First, about 75% of the seventh graders know the order of sizes (Sun>Earth>moon), whereas only 34.4% of the younger children know the sun is the biggest. Second, 43.3% of the younger children think that the Earth is bigger than the Sun; however, only 8.6% of the seventh graders do. The seventh graders were more able to use scientific explanations; while the younger children's explanations were based more on ego-centered points of view. Third, the younger children answered that the stars are the smallest, whereas the older children were able to consider the stars with different sizes (such as bigger than the sun). Fourth, the seventh graders consider the stars are the farthest then the Sun and the moon (51.6%); while the younger children consider the stars are the closest than the moon and the Sun (23.3%). A few of the younger children even considered the Sun to be the closest of the three (21.1%).

M2.10

MIDDLE SCHOOL STUDENTS' EXPLANATIONS OF GLOBAL WARMING: APPROPRIATE AND INAPPROPRIATE CONCEPTIONS FOLLOWING STS INSTRUCTION
James A. Rye and Peter A. Rubba, Penn State University, and Randall L. Wiesenmayer, West Virginia University

The purpose was to investigate middle school students' understandings of global warming (GW) following instruction using teacher developed science-technology-society (STS) units. Students' perceptions of connections between GW and ozone related environmental problems also were examined. Subjects were 26 students enrolled in grades 6-8. Standardized open-ended interviews were conducted within one month following unit instruction. The content and frequency of student responses was determined and student understanding of GW was assessed using an expert concept map. The majority of students gave evidence that taking action to resolve GW is important and were aware of a variety of actions. However, the majority of students also held the inappropriate conception that the ozone hole is a major cause of GW; more than one-third implied CFCs role in GW was limited to destruction of ozone and that carbon dioxide destroys the ozone. These and other limited conceptions have serious implications for student understanding of GW and suggest that ascertaining students' existing views of GW and ozone is a prerequisite to GW instruction.

M2.10

A COMPARISON OF SELECTED MARINE ECOLOGY TOPICS AND SOURCES OF KNOWLEDGE AMONG FOURTH GRADE RESIDENTS OF COASTAL AND INLAND SOUTH TEXAS COMMUNITIES
Robert B. McDonald and Lowell J. Bethel, The University of Texas at Austin

The purpose of this investigation was to compare the knowledge regarding marine organisms and their feeding relationships of fourth grade residents of one coastal and one inland community in south Texas and to generate grounded theory concerning the particpants' construction of such knowledge. Four male and four female students were randomly selected from the fourth grade populations at one coastal and one inland site(n=16). Both free-recall and stimulated clinical interviewing strategies were employed to examine each participant's knowledge of the selected topics. Participant responses were compared across the variables of gender and region of residence. Overall, coastal residents were aware of more marine organisms than were inland residents, especially those organisms native to the waters near their home community. Gender was not shown to be a significant variable. Students from both groups were found to rely upon a limited number of critical physical attributes to identify marine organsisms. A majority of the most commonly named organisms were those that the participants identified as being dangerous to humans. All of the participants were found to rely primarily upon a size-dependent, predator dominated "big fish eat little fish" framework when constructing understanding of marine trophic relationships.

M2.11

TEACHERS' KNOWLEDGE OF SOCIOLOGY OF SCIENCE.
Christine M. Cunningham, Cornell University

This paper expands the prevailing conception of pedagogical content knowledge to incorporate contemporary views of the sociology of science. The utility of this conception is then demonstrated in a study of interdisciplinary science teaching by teams of secondary science teachers. I describe what is meant by a sociological understanding of science (SUS), drawing upon both the literatures on teacher subject-matter knowledge and a recent review of sociology of science and its implications for education. I present findings from a doctoral study investigating the impact of SUS on teachers' instructional planning and school-year implementation of innovative interdisciplinary curriculum projects. Finally, I outline implications of this research for inservice and preservice teacher education, in the light of recent reform initiatives that call for greater attention in science teaching to the social context and application of science .

M2.11

MULTICULTURAL SCIENCE EDUCTION: MAPPING TEACHERS' EPISTEMIC TERRAIN IN RELATION TO POWER, PURPOSE AND THE GOALS OF MULTICULTURAL SCIENCE EDUCATION.

Deborah Tippins, University of Georgia; Sharon Nichols, Florida State University; Denise Crockett, University of Georgia.

Little has been written in science education research concerning how science teachers locate themselves culturally and perceive their own experiences in learning in relation to their beliefs about multiculturalism in science teaching. The purpose of this study was to investigate science teachers' epistemological perspectives and their beliefs about science teaching in relation to conceptions of culture, issues of power, and knowledge of the goals of multicultural science education. Teacher participants in the study were from culturally diverse backgrounds including: Mennonite teachers in rural private schools, Navajo and Hopi teachers in public reservation schools and teachers from a predominantly white, southern, urban school. This interpretive study utilized qualitative methods of data collection and analysis. Case studies involving teachers from each setting are used to illustrate central understandings derived from the study. Key findings of the study include the way in which teachers' world views reflect conceptions of power and culture in relation to "transmission" or "constructivist" beliefs about science teaching and the contextual nature of what was perceived by participants to be meaningful and empowering in terms of science learning.

M2.12

SCIENCE EDUCATION IN DEVELOPED AND DEVELOPING COUNTRIES FROM THEORY TO PRACTICE: A SYNTHESIS OF THE INTERNATIONAL CONFERENCE HELD IN JERUSALEM JANUARY 1993

Avi Hofstein, Weizmann Institute of Science, Israel and Geoff Giddings, Curtin University of Technology, Australia

In January 1993 an International Conference was held in Jerusalem. The title of the conference was Science education in developing countries from theory to practice. About 350 participants from 50 countries (both developed and developing) met to discuss issues and concerns regarding four important strands: "The student", "The teacher", "The classroom" and "The curriculum". The main goals of this conference were to: review past experiences about theory and practice of science education in both developed and developing countries; identify factors influencing successful practice of science education in different parts of the world; identify priorities for science education research and development in the 21st century: The question as to how to attain these goals was contained in the subtitle of the conference namely "from theory to practice". The symposium will provide a critical analysis of these goals and will focus on the relationships between theory and practice in science education in both developed and developing countries.

M2.13

CULTURE: IMPLICATIONS FOR TEACHING

Mary M. Atwater, The University of Georgia; Alejandro Gallard-Martinez, Florida State University; Pamela F. Abder, New York University; Randy McGinnis, University of Maryland

The purpose of this panel is to discuss culture and its implications for teaching based upon research conducted in three different types of school setting: urban, city, and international. Since the key elements in schooling are believed to be the teacher, the learner, the curriculum, and the context, and evaluation (Novak & Gowin, 1984), more research is needed on how the teacher's and learner's cultural beliefs and values influence the science learning in the classroom. Many schools in this country are diversifying, while other schools have teachers whose cultures are different from the cultures of their students. In some schools in this country and the world, the teachers' and students' culture are similar. How then do teacher beliefs and value systems about the culture of their students influence their actions in the learning? How are decisions made by science teachers in these kinds of classrooms? What kinds of science curricula are used in the science classrooms that are bicultural or multicultural? Finally, how do you get teachers to be willing to have their science teaching be influenced by their students' culture? These questions and others have been raised by the four panelists in their research in teacher education.

All of these panelists will share their different findings; however one finding is that teachers must become sensitized to the need to consider their students' culture and then become knowledgeable and develop skills to consider the cultures of their students in their classrooms. The development of the knowledge and skills to accomplish this cannot occur in one day workshops, but evolves over time.

M4.01

DIMENSIONS OF GENDER-INCLUSIVENESS: HIGH SCHOOL STUDENTS' ATTITUDES AND PERCEPTIONS ABOUT SCIENCE, MATHEMATICS AND ENGLISH

Léonie Rennie, Lesley Parker, Mary Kepert, Leonie Maley, Kerry Mollett, Sue Stocklmayer, and Joanne Tims, Curtin University of Technology

This study investigated students' affect about science, mathematics and English and their perceptions of the nature of classroom interaction and behavior in their typical science, mathematics and English classrooms. Measures were developed in an attempt to establish from an interpretation of students' perceptions, the extent to which subjects and classrooms were gender-inclusive. Data were collected from nearly 2000 high school students, 8th through 12th grade, using matched instruments for science, mathematics and English. Analysis of the data revealed that generally, males had more positive affect about science and mathematics than did females, and the reverse was true for English. The existence of clusters of classroom behaviors as students perceived them was also revealed, and within these clusters sex differences were detected consistent with those reported in the literature. The purpose of the round table is to facilitate critical discussion of the value of this kind of data in research on thegender-inclusiveness of classrooms.

M4.02

Visions of Science Education in the New Century: Issues Related to the Uses of Technology

Robert Sherwood, Vanderbilt University; Jay Lemke, CUNY; Carl Berger, University of Michigan; Steven Hodas, University of Washington; David Jackson, University of Georgia; Michael Klapper, Ohio State University; Bill Baird, Auburn University

Every technological advance is nominated as the next savior of American education. Film, radio, television, and even airplanes have in their time been promoted as our deliverance from educational mediocrity, inconsistency, inequity, and/or inefficiency. Recent experiences with microcomputer networks and, more recent still, with virtual-reality based curricula seem to hold promise for a significant change in practice. It is doubtful, however, that the promise can be fulfilled within the larger technology constituted by the values and practices of existing school organization. The symposium will attempt to create a dialogue between the panel members and the audience about shared visions of what science education could look like in the new century. The symposium will attempt to address questions and issues related to the increase in research and development activity in using technology in science education and provide some indications from both the cognitive science and technology literatures of pathways that might be most productive.

M4.03

TRENDS IN BIOLOGICAL EDUCATION: TEACHING, TEXTBOOKS AND EVOLUTION. Thomas M. Mastrilli and Sandra B. Bobick, University of Pittsburgh

This paper presents a critical examination of standard biology textbooks from 1890 to 1980, with a focus on how evolution-related information was treated and a parallel examination of the biology curriculum of the same period. The analysis centered on documenting scientific thinking of the time, and providing an historical perspective of the teaching, textbooks, and treatment of evolution for a given period. This examination provided a framework within which specific recommendations of various committees could be reviewed. Results of the analysis center on three major themes: 1) sporadic treatment of evolution, 2) partial implementation of committee recommendations at the classroom level, and 3) a significant lag time between new concepts and their appearance in the curriculum and textbooks.

M4.03

SHIFTING TO AN INQUIRY BASED CLASSROOM: EFFECTS AND RECOMMENDATIONS

Melissa J. Erickson, Edwin F Taylor, & Linda S. Shore, Polymer Center Education Projects, Boston University
Paul Hickman, Belmont High School

The purpose of this study was to document the effects of using materials based on current scientific research in the high school science classroom. A teacher and his students in two consecutive academic years were observed. Through the use of ethnographic field notes, a shift in the type of guidance the teacher offered his students was recorded. During the second year the teacher's guidance strategy closely resembled the model of "cognitive apprenticeship". This change in teaching strategy was observed to effect student behavior and concept development. Student behavior was documented through time coded field notes and concept development was monitored through the use of student concept maps.

M4.03

THE NATURE OF EXEMPLARY PRACTICE IN SECONDARY SCHOOL LABORATORY INSTRUCTION: A CASE STUDY INVESTIGATION.

William F. McComas, University of Southern California

This study investigated how exemplary laboratory secondary school instructors organize and implement laboratory instruction by exploring their rationales, goals and pedagogical knowledge. Highly-skilled laboratory teachers were identified by using an initial literature-based list of criteria for excellence. Qualitative data sources included in-class observations, videotaping, on-site field notes, inspection of lesson materials and interviews. Quantitative data were provided by measures of group engagement time and teacher behaviors obtained with the *Science Laboratory Interaction Categories* instrument.

Each exemplary teacher is represented by a case-study derived from data provided by the observations, interview transcripts and measures of teacher-student interactions. A refined list of criteria for exemplary practice based on the common practices, attitudes and knowledge held by the subjects was developed based on generalizations seen.

M4.03

ASSESSMENT AFFECTS INSTRUCTION: A THIRD GRADE STUDIES DOLPHINS AND ENVIRONMENTAL ISSUES

Betty Wier, University of Delaware
Jean Leach, West Park Place Elementary School

The objective of this paper is to (1) examine third graders' ideas about dolphins and related environmental issues as assessed pre and post instruction through clinical interviews; (2) explain how the interview responses influenced the teacher's instruction; and (3) describe how a whole class assessment was designed which would permit the teacher to assess students' pre and post instruction understandings using an alternative to time consuming individual interviews. One half of the students in a third grade class involved in the study of several topics related by an environmental theme were interviewed about dolphins. Interviews included questions about dolphin characteristics/classification, and ethical and environmental issues. Although post interview responses indicated general gains in knowledge, there were some cases where alternative conceptions appeared. For example, students who previously classified dolphins as animals now described them as "more mammal than animal." Based on the student post interview responses, lessons were revised and a written alternative assessment was developed.

M4.04

THE NATURE OF FOURTH GRADERS' UNDERSTANDING OF ELECTRIC CIRCUITS AND THE ROLE OF ANOMALOUS DATA.

Daniel P. Shepardson, and Elizabeth B. Moje, Purdue University.

This investigation involved a case study of the nature of fourth grade children's understanding of electric circuits and how their understandings provided them with frameworks for interpreting data derived from the observation and manipulation of electric circuits. The consistency, detail, and coherence of children's understandings influence the power of their frameworks for interpreting electric circuit data. The study elucidates how children's interpretive frameworks of electric circuits allowed them to recognize data as anomalous, supportive, or erroneous. Specifically, the importance and role of anomalous data in creating conflict, challenging children's interpretive frameworks was investigated. Preliminary findings suggest the following emerging patterns: 1. Children's interpretive framework of electric circuits are reflected in the consistency, coherence, and detail of their understanding. 2.The consistency, coherence, and detail of children's understandings influenced their interpretive frameworks, and thus, their ability to view data as anomalous, supportive or erroneous. 3.Children whose interpretive frameworks enabled them to view the electric circuit data as anomalous were challenged to change their understandings of electric circuits. 4.Children whose interpretive frameworks enabled them to view the electric circuit data as supportive evidence were not challenged to change, but to modify or reinforce their understandings of electric circuits.

M4.04

CONCEPT LEARNING AND PROBLEM SOLVING IN HIGH SCHOOL CHEMISTRY

Rosemary F. Leary, Mesa Community College

This study investigated the relationship between concept learning and problem solving in traditional and in concept mapping chemistry classes. Five intact classes of students, all of whom had the same teacher, participated in the study. Students were assessed in verbal, spatial, quantitative, and scientific reasoning. Pre and posttests in chemical composition and stoichiometry were also given. Results indicated that the students who used concept maps and who had TOLT scores of 5 to 9 outperformed similar control students in concept learning. Differences were also found between the correlation coefficients for each of the four cognitive attributes and concept learning and problem solving achievement for each of the two groups.

M4.04

USE OF TEACHING EXPERIMENT METHODOLOGY TO STUDY THE DEVELOPMENT OF REASONING IN LABORATORY / PRACTICAL INVESTIGATIONS.

Ed van den Berg, Vrije Universiteit, Amsterdam, Netherlands
Nggandi Katu, Universitas Kristen Satya Wacana, Indonesia
Vincent N. Lunetta, Penn State University, USA

A "teaching experiment" design was used to investigate in detail the development of a student's conceptions of electric circuits and the development of his related reasoning . This paper reports the results of a study with one Indonesian tenth grade student who was interviewed in three one hour sessions to determine the status of his conceptions. Later the "teacher-researcher" conducted five one hour teaching-interview sessions during which the student developed his conceptions. In the teaching sessions, the student investigated circuits containing batteries, bulbs, and resistors which he designed, set up, and studied in dialogue with the teacher-researcher. All interviews were video taped, transcribed, translated (from Indonesian) and validated by observers. Throughout the series of interviews the student's attitudes toward physics investigations and his reasoning about them changed markedly. The student became more confident and proficient in using the investigations to improve his knowledge structure. Changes in attitudes and reasoning and the ways used to assess those changes are described in the paper.

M4.04

THE RELATIONSHIP BETWEEN KNOWING HOW TO CONSTRUCT GRAPHS AND HOW TO INTERPRET GRAPHS.
Michael J. Wavering, University of Arkansas.

The purpose of this study was to describe the relationship between knowing how to construct graphs and how to interpret graphs. One hundred eighty-nine students in grades 7-12 were given a multiple choice instrument which required graph interpretation and also asked to construct a graph from a set of data. Analysis of the results indicated that there was a moderate correlation between scores on the graph interpretation instrument and the graph construction instrument. Additional analysis investigated the nature of the questions and the levels on the graphing instrument and item difficulty was compared to the level on graph construction. This research was conducted to illuminate such questions as how much graphing detail and interpretation should be taught and when it should be taught.

M4.05

SCIENTISTS, TEACHERS, NATURAL RESOURCE MANAGERS AND NATIONAL SCIENCE CURRICULUM REFORM
Michael J. Brody, Montana State University

The development of the National Project WET (Water Education for Teachers) curriculum framework has been based on three major factors: existing water education efforts throughout the United States, the development of guidelines for national science curriculum reform and an empirical study of scientists', teachers', and water resource managers' beliefs about water resource education. A review of existing water education curricula revealed a regional and local focus and in most cases a narrow scope of water related subjects addressed in each curriculum. A review of the development of national science curriculum standards by the American Association for the Advancement of Science, the National Science Teachers Association and the National Research Council revealed a number of teaching and learning principles. Finally, results of a Delphi survey of scientists, teachers and resource managers indicated that water and water resource education should include concepts, process skills and affective components which are congruent with national curriculum reform and the Project WET curriculum framework.

M4.05

A REVIEW OF RESEARCH INTO STS SCIENCE
Glen S. Aikenhead, University of Saskatchewan

Do students actually benefit from studying school science through an STS approach? Research accumulated internationally over the past 30 years supports the conclusion that students do benefit. STS science instruction can achieve its definable objectives (for example, STS content, science content, science processes, and attitude objectives) in a number of different settings, as evidenced by summative evaluation studies many of which make direct comparisons to the outcomes of "traditional" science classes. Formative evaluation and status studies add weight to this conclusion, as do studies into the effect of high school science instruction on university science achievement.

M4.05

EQUITY, CONSTRUCTIVISM AND SCIENCE-TECHNOLOGY-SOCIETY: DEFINING THE DIRECTION OF A NEXT GENERATION OF SCIENCE CURRICULA MaryAnn Varanka Martin, Estes Park High School, Estes Park, CO

Three issues--who to teach, how to teach and what to teach--that emerge from the literature suggest new directions for a next generation of science curricula. These issues are represented by three dipolar pairs 1) who to teach--**equity** and **excellence**, 2) how to teach--**constructivism** and **transmissivism**, and 3) what to teach--**STS** and **science-as-a-discipline** which can be represented as a three dimensional grid. Criteria for each of these dipolar pairs have been generated and applied to ChemCom as a test of the grid and criteria for locating curricula with characteristics of the new directions. Analysis of student learning data from standardized test scores, concept maps and ConnMaps and the written curriculum provide the basis for placement of ChemCom on the locator grid composed from the three dipolar pairs. ChemCom demonstrates a strong **STS** component, a moderate **equity** component and a faint **constructivism** component.

M4.05

THE EFFECTS OF AN INTERDISCIPLINARY CURRICULUM UNIT ON THE ENVIRONMENTAL DECISION-MAKING OF SECONDARY SCHOOL STUDENTS

Amanda W. McConney, Andrew McConney, Western Michigan University, and Phillip Horton, Florida Institute of Technology

The first phase of this study involved the development of an interdisciplinary curriculum unit centered on the concept of sustainable development in tropical rainforests. The centerpiece of the interdisciplinary unit was the investigation of a simulated problem which required students to develop, weigh, and then decide on a spectrum of possible solutions. In the second phase of the study, nine science teachers implemented the unit in their classrooms after attending a two-day training workshop. Teachers then administered environmental decision-making pretests to their students who had been randomly assigned in intact classes to experimental (interdisciplinary rainforest curriculum unit) and control (conventional curriculum) groups. On completion of the three week unit, posttests were completed by both experimental and control students. This study's inferential results implied that students exposed to the interdisciplinary curriculum unit offered more supporting statements for their environmental decisions as compared to control students. It was also evident that females used more alternative reasoning categories than their male counterparts when reaching an environmental decision. These results support the use of interdisciplinary curricula for enriching the environmental decision-making of secondary school students.

M4.06

THE DEVELOPMENT OF AN INSTRUMENT FOR ASSESSING THE LEARNING ENVIRONMENT OF SCIENCE OUTDOOR ACTIVITIES.

Nir Orion & Avi Hofstein, The Weizmann Institute of Science
Pinchas Tamir, The Hebrew University
Geoffrey Giddings, Curtin University of Technology

The SOLEI (Science Outdoor Learning Environment) was developed and content validated in high schools in Israel. The instrument consists of seven scales (55 items). Five of the scales are based on the Science Laboratory Learning Environment Instrument developed in Australia. The other two are unique to the learning environment existing in outdoor activities. The instrument was found to be a sensitive measure that differentiates between different types of field trips conducted in the context of different subjects (chemistry, biology and earth sciences). It is suggested that the instrument could be an important addition to research studies conducted in informal settings in science education.

M4.06

REVISED SCIENCE ATTITUDE SCALE FOR PRESERVICE ELEMENTARY TEACHERS: RE-EXAMINED.

Betty L. Bitner, Southwest Missouri State University

The content and construct validity and reliability of the Revised Science Attitude Scale for Preservice Teachers as a scale for measuring the attitude of preservice elementary teachers toward the teaching of science were re-examined. The instrument is intended to measure four subcomponents: comfort-discomfort, need, time, and equipment. Data were generated on two subsamples ($n_1 = 59$ and $n_2 = 60$) and the sample ($N = 378$). Frequency, intercorrelations, Cronbach's Alpha, and principal components analysis with varimax rotation were used to analyze the data. Means tended to fall within the 2.00 and 4.00 range with standard deviations hovering around 1.00. Neutral responses beyond 35% were limited to item 7. Five factors were extracted in the principal components analysis, explaining 55.1% of the variance. Eight statements failed to load on any factor. Statements of teacher anticipation about teaching science loaded on Factor 1. The subcomponent comfort-discomfort loaded heavily on Factors II and III. Loadings on Factors IV and V were fairly well distributed across the four subcomponents designated by the scale developers. Reclassification of some statements seems warranted.

M4.06

A CLASSROOM ENVIRONMENT QUESTIONNAIRE FOR THE CONSTRUCTIVIST REFORM OF SCHOOL SCIENCE

Peter CS Taylor and Barry J Fraser, Curtin University, Australia

A revised version of the Constructivist Learning Environment Survey (CLES) has been developed for researchers who are interested in the constructivist reform of high school science. Constructivist theory and critical theory have been combined to create a powerful interpretive framework for examining science teaching. The narrow cognitivist focus of the earlier instrument has been replaced by a concern for the socio-cultural forces that shape the rationality of traditional science classrooms. The revised CLES questionnaire assesses five dimensions concerned with: (a) increasing the personal relevance to students of school science instruction; (b) engaging students in reflective negotiations with each other; (c) teachers inviting students to share control of the design, management, and evaluation of their learning; (d) students being empowered to express critical concern about the quality of teaching and learning activities; and (e) students understanding the culturally-determined and uncertain nature of scientific knowledge. The revised questionnaire has been validated by triangulation with classroom observations and by trials with a sample of over 300 students in high school classrooms. The questionnaire provides constructivist-oriented teacher-researchers with an efficient means of supplementing interview and observation data as they monitor the impact on students of their instructional innovations.

M4.07

SCIENCE CONCEPTUAL CHANGE IN MIDDLE SCHOOL: SIX CASE STUDIES

Kathryn F. Cochran, Charles, Fisher, Linda Warner, & Alice Horton
University of Northern Colorado

In this research, six case studies focused on students' conceptual understandings about science in middle school. The unit focused on diversity in animals, and was organized around 12 major classifications of animals at the phylum/class level. Six students were chosen as cases, one girl and one boy each in 6th, 7th, and 8th grades. All classes and interviews were videotaped and transcribed. Concept maps were analyzed for misconceptions and evidence of conceptual change by identifying and tracing schema across time; analyzing the types, numbers, and directions of the links; and an analysis of the number and types of concepts added to the maps. The analyses revealed both consistency and change across concept maps. Changes in the maps included the gradual disappearance of initial misconceptions as well as the surfacing of a few on later maps. One aspect of conceptual change was indicated by increasing numbers of added concepts that were examples or characteristics. The most abstract concepts were generally interrelated in a very limited and highly undergeneralized manner initially, and were more broadly connected as instruction proceeded. These data tentatively suggest that conceptual change might differ for different types of concepts.

M4.07

VALIDATING CHILDREN'S SCIENCE: KNOWLEDGE CONSTRUCTION IN ACTION

Shirley Magnusson, Robert Boyle, The Univ. of Michigan
Mark Templin, The University of Michigan

Many studies of conceptual change in science have not been conducted in ways consistent with constructivism which emphasizes that change occurs within individuals engaged in personally meaningful activity. Previous studies have generally focused on static end-states of knowledge and their match with scientifically-accepted knowledge, disregarding the process of change and intermediate steps in the process. Our work was designed to examine knowledge construction in action by placing students in contexts similar to instruction where they are asked to make predictions and explain patterns in their observations. We worked with upper elementary school students and dealt with electrical circuits and the concept of current. Examining learning in science in this way allowed us to identify themes in the *processes* and *products* of knowledge construction. We identified how prior knowledge and the physical configuration of the phenomenon influenced perception and explanation, but we also documented many instances of willingness to change ideas, suspend beliefs, and reconsider conclusions.

M4.07

PATTERNS OF CONCEPTUAL CHANGE IN EVOLUTION

Sherry S. Demastes, Ronald G. Good, and Patsye Peebles,
Louisiana State University

The purpose of this study was to investigate the patterns of students' conceptual restructuring within the theoretical framework of biological evolution. The study drew on conceptual change theory in an effort to define the limits of the theory and suggest other models of restructuring. In a series of 18 clinical and unstructured interviews with four participants, the students' changing conceptions about facets of evolutionary theory were documented. Questions for the interviews were developed from the wealth of alternative conceptions documented in the literature. The conceptual change documented demonstrates that many conceptions in this content area are closely interwoven, so that a change in one conception requires a change in many others. Three patterns of conception change were seen, (a) holistic, (b) fragmented, gradual, and (c) dual constructions. Of these three, only the first conforms to the changes described by conceptual change theory. The other two patterns suggest that different models of conceptual change are required for science education research.

M4.07

CONCEPTUAL CHANGE APPROACH TO LEARNING SCIENCE: THE DYNAMIC ASPECTS OF METACOGNITION.

M. Gertrude Hennessey, St. Ann's School, Stoughton, WI, USA

Project META (Metacognitive Enhancing Teaching Activities) is a three-year naturalistic case study that follows the classroom interactions and development of physical science concepts of six cohorts of students (grades 1-6) across three academic years. Its purpose is to explicitly enhance the metacognitive capabilities of learners in order to: (1) illuminate the nature of metacognitive interactions among elementary science students, and (2) describe the impact this type of interaction has on conceptual knowledge formation. One of the dramatic outcomes has been the apparent diversity of forms in which "metacognitive statements" present themselves; both across individuals and within the same individual in different contexts. This paper treats the nature of that diversity, associated not with propositional knowledge or beliefs per se, but with metaphysical beliefs and the function of epistemological commitments. A second outcome has been the impressive ability of students to: (1) provide rich descriptions of their conceptions and the epistemic and metaphysical beliefs that effect those conceptions; and (2) develop and use the constructs of status when discussing science concepts and, in the process, provide evidence for specific components of their conceptual ecologies that influence conceptual understanding. Results of this study lead to a number of principles about metacognition that apply to conceptual change, which are discussed in the paper.

M4.08

ENSENANZA DE LAS MATEMATICAS EN LA EDUCACION SECUNDARIA

Myriam Acevedo Caicedo, y Crescencio Huertas Campos, Universidad Nacional de Colombia, Colombia

Esta investigación es parte del proyecto universitario de investigación: Enseñanza de las Ciencias. Pretende ser un aporte para la cualificación de los docentes de matemáticas en la educación básica y secundaria, a través de un programa de capacitación que permita la clarificación y profundización de dos conceptos fundamentales de la matemática como son el número y la medida, para dar a los alumnos una formación sólida y estructurada. Se mira el aprendizaje matemático como la adquisición de hechos relevantes, conceptos, principios y herramientas, resultado de una interacción social. Se minimiza la distancia entre aspectos teóricos de los contenidos y su aplicación.

M4.08

DISEÑO DE INSTRUMENTOS HIPERMEDIALES EN LA ENSENANZA DE LA QUIMICA Y LA BIOLOGIA

Antonio E. Benavente Morales, Universidad Nacional de San Agustín de Arequipa, Peru

Puesto que hay razones que justifican la utilización de computadoras en la educación concebidas como un medio y como un fin en la enseñanza conociendo, además, la efectividad de su uso como recurso en el aula, hemos trabajado en los últimos tres años en la parte operativa de esta propuesta: la creación y diseño de "software" de simulación de procesos químicos y biológicos para hacer la enseñanza más efectiva y motivadora. Utilizamos para ello toda la tecnología que requiere un entorno multimedia, imagen animada, sonido, texto e hipertexto, a la vez. Las pruebas realizadas han dado alentadores resultados, aún a pesar del costo de la infraestructura necesaria para utilizar estos recursos. Cualitativamente hablando los alumnos muestran estar mejor motivados, evocan con mayor efectividad las lecciones, participan en ellas de manera interactiva con la máquina, desarrollan sus propias experiencias, ejercitan lo que se denomina procesos mentales elevados (conocimiento, comprensión, aplicación, análisis, síntesis y evaluación) y lo que es mejor, se divierten aprendiendo. Esta no es la solución, sino una alternativa para ciertos casos y en determinados niveles en los que por razones de economía de recursos, tiempo, imposibilidad física u otros se hace conveniente esquematizar la realidad. Para esto hay que atender a criterios de racionalidad, economía, eficiencia y eficacia.

M4.08

METODOS DE ENSENANZA UTILIZADOS POR LOS PROFESORES DE CIENCIAS PARA DESARROLLAR EL PENSAMIENTO CRITICO

Deyanira Barnett, y Lydia de Isaacs, Lydia, Universidad de Panamá, Panamá

Durante la década del ochenta numerosas organizaciones educativas e invesigativas han reconocido que el desarrollo del pensamiento en los estudiantes debe ser una prioridad (Perkins 1986; Bransford y otros, 1936: Logan 1987) Esta investigación se basa en la creencia de que para enseñar, para promover el desarrollo del pensamiento y del pensamiento crítico en particular, el maestro debe tener un concepto claro sobre lo que es el pensamiento crítico y sobre los métodos de enseñanza que promueven esta destreza; es más, debe reflexionar acerca de su propia práctica para determinar si realmente existen obstáculos para que él cumpla con esta tarea prioritaria en educación que es promover el desarrollo del pensamiento de sus estudiantes. Los propósitos de este estudio son: - determinar el conocimiento que tienen los maestros de ciencias acerca del pensamiento crítico y de los métodos de enseñanza para su desarrollo. - identificar los obstáculos que, según los maestros, influyen en su práctica limitando el uso de metodologías para el desarrollo del pensamiento crítico.

M4.08

REDES CONCEPTUALES PARTE II: CASOS DE APLICACION EN TEMAS DE FISICA DE NIVEL MEDIO

Lydia R. Galagovsky, y Nora Ciliberti, Universidad de Buenos Aires, Argentina

Una vez definidas las consignas para la confección de redes conceptuales, estas fueron probadas como instrumento didáctico en temas de Cinemática con alumnos de tercer año de nivel medio. El cambio conceptual perdurable registrado en los alumnos, luego del receso escolar nos estimuló a continuar la investigación con el tema Dinámica y los mismos alumnos, ya cursantes el cuarto año de bachillerato.

M4.10

EXLORATIONS OF THE ROLE OF PORTFOLIOS IN THE DEVELOPMENT OF PEDAGOGICAL CONTENT KNOWLEDGE

Thomas M. Dana, Penn State, Deborah Tippins, University of Georgia, and Michael Kamen, Auburn University

The purpose of these studies was to consider what prospective teachers learn through the development of portfolios. Three science teacher educators from different universities collaborated to study the nature of the portfolio experience in the construction and reconstruction of the pedagogical content knowledge of prospective science teachers. These studies used parallel methods of inquiry. A naturalistic study which involved in-depth interviewing as a primary mode of data collection was utilized in this design. Additional sources of data were "portfolio letters" generated during the development of the portfolio, and the portfolios themselves. Several working hypotheses have been generated from cross case analyses of the individual data sets. Conceptualized metaphorically, they are: (a) Portfolio as a Reflective Tool, Portfolio as a Window to Teacher's Conceptions, and Portfolio as a Facilitator of Conceptual Change. Implications are drawn for the possibilities of portfolio usage with prospective teachers.

M4.11

Needed! Quality Evaluation of Teacher Enhancement Projects.

James D. Ellis, BSCS; Larry G. Enochs, University of Wisconsin - Milwaukee; and Floyd E. Mattheis, East Carolina University

With more than $500 million in support from NSF and additional support from other federal, state, and private foundations during the past decade, teacher enhancement is the single largest activity engaged in the reform of education in precollege science and mathematics. If as much as 10 percent of the budget of each teacher enhancement project were allocated for evaluation and research, NSF would spend more than $10 million annually on such studies, which exceeds the 1994 budget for the NSF Division of Research, Evaluation, and Dissemination. With such high stakes, NARST members should collaborate with principal investigators of teacher enhancement projects (many of which are scientists) in their state and region to ensure that the research and evaluation components of current and future teacher enhancement projects make meaningful contributions to science education. During the symposium, the presenters will respond to questions about the design and conduct of evaluation studies, referring to examples from teacher enhancement projects. The audience will seek consensus on the issues and discuss the role of NARST in encouraging quality evaluation studies.

M4.12

STUDENT PERCEPTIONS OF BARRIERS TO SUCCESS IN A UNIVERSITY GENERAL CHEMISTRY COURSE

Glen H. Bennett, University of Maryland at College Park

This study examined the perceptions of 171 students and 6 teaching assistants (instructors) regarding lecture and discussion session activities and procedures in a university general chemistry class. Data sources included a student survey, extensive instructor interviews, and discussion session transcripts for the first eight weeks of the semester. Results were analyzed by commonly used qualitative methods (Goetz & LeCompte, 1984; Seidman, 1991). Forty-four percent of students believed that grading was too strict. A related finding was that 23% of students said that there was insufficient time to complete quizzes and tests. Students reported significant differences between homework problems and problems appearing on quizzes and tests. Instructors improved their class presentations as the semester progressed, but many pedagogical deficiencies remained unaddressed. For example, instructors displayed a short wait time for answers to their questions. Providing students with step by step solutions to key problems tended to most benefit students who were already making high grades. This procedure had the unintended effect of structuring discussion sessions for instructors, allowing them to spend minimal preparation time. Consequently, instructors often experienced difficulty answering questions about problems other than the key problems.

M4.12

CONCEPT MAPS AS HUMAN-COMPUTER INTERFACES FOR LEARNING SCIENCE

Jaime Sánchez, University of Antofagasta, Antofagasta, Chile.

This study examines the use of concept maps as human-computer interfaces for learning biology. Concept mapping is used as a powerful strategy to help learners to learn how to learn and think with computers and to ameliorate current cognitive overhead problems of most hypermedia software. Thus a hypermedia software to assist the learning of biology at secondary school level was constructed and its effectiveness was determined by using qualitative research methods. As a result we developed a hypermedia that uses diverse built-in cognitive maps for several purposes such as constructivist testing, on-line dictionary, and general and specific navigation maps. These computer learning sources were also used to help the learner-computer interaction in science learning environments. As a result, we present a qualitatively validated fine piece of science learning hypermedia software with specific emphasis on the use of concept maps as a powerful computer-based learning tools as well as human-computer interfaces for learning science. We believe that both critical uses of concept maps in computer-based learning help learners to construct knowledge and make meaning.

M4.12

MOTIVATING STUDENTS TO ENGAGE IN SCIENCE CONTENT AND STRATEGIC KNOWLEDGE
William G. Holliday, University of Maryland at College Park

This theoretical paper on teaching science content (e. g., concepts such as force) and strategic knowledge (e. g., processes such as interpreting data) integrates two interactive data-based models—cognition, and motivation, focusing on science contextual factors. Effective science teachers motivate students to engage in cognitive tasks by teaching them how to solve problems, and improve students' conceptualizations and imaginations. During engagement, motivated students also learn about science while assimilating, remembering, and transferring information to new contexts. In an effort to link cognition (and metacognition) to achievement motivation, two interactive models are described. The first includes three interrelated components: (a) students' cognitive strategies, (b) selected metacognitive strategies, and (c) other metacognitive strategies of management and control. Data collected recently from cognitive and metacognitive studies has led to the formation of a second three-component model of achievement motivation: (a) students' expectations, (b) values, and (c) affective and emotional reactions. The relationship between cognitively oriented motivation, tasks, enjoyment, and attitude changes in science teaching are also discussed in this paper.

MONDAY AFTERNOON

M6.02

IMPROVED SCIENCE CONTENT FOR PRE-SERVICE TEACHERS: MODELING OF TEACHING STRATEGIES BASED ON CURRENT SCIENCE EDUCATION REFORM LITERATURE.
Kathie M. Black, Ph.D., University of Victoria

Internationlly universities are struggling with science education reform. Current literature suggests ways in which science education can be improved within schools; however, curriculum implementation based on current literature has not been achieved. It is hoped that this study will add to the planning and implementation of current science education reform for the 21st Century by struggling with and addressing these areas, thus eliminating "reinvention of the wheel." Many challenges have been made to improve science education in terms of improved science content in ways that model appropriate teaching strategies of the classroom teacher. This study is made in response to those challenges. Treatment provided for students at The University of New Mexico based on recommendations of current science education reform literature resulted in significant changes in student attitudes toward science, their overall sense of the relationship between science content and ways of learning, and their ratings of future computer usage in the classroom.

SPECIAL SESSION

M4.13

NATIONAL SCIENCE EDUCATION STANDARDS AND SCIENCE EDUCATION RESEARCH.
Angelo Collins, Rodger Bybee, Audrey Champagne, Karen Worth, National Research Council

The National Science Education Standards Project convened by the National Research Council, will release a draft of science education standards for teaching, content, assessment, program and policy in the Spring, 1994. The purpose of the draft is to provoke discussion among those concerned with science education. Researchers will be interested in this draft for two reasons: how the standards incorporate current research in science education and how the standards will influence science education research in the future. This panel will provide a forum for science education researchers to participate in the science standards endeavor. The chairs of the working groups will lead discussion on the standards, the research base that supports them, issues surrounding them and research that might be done as a result of the standards being published. The majority of the time allotted the panel will be spent responding to those attending the session.

M6.02

SCIENCE TEACHER SUPPLY IN THE UNITED STATES
Sharon P. Hudson, Lincoln Public Schools

This study assessed the supply of American science teachers in 1992 compared to the supply in 1982. Ninety-six percent of the State Science Consultants of the fifty State Boards of Education responded to the survey. The supply of teachers was evaluated for the nation and for four geographical regions--the Northeast, Southeast, Central and West. Science teacher shortages were reported in all science subjects and were particularly critical in physics, chemistry and earth science. Comparison of Howe and Gerlovich's 1982 data with the 1992 data showed significant improvements in the supply of teachers in chemistry, physics and earth science. Although the national shortage of science teachers has improved over the last ten years, there are still critical shortages of science teachers in all regions, especially in the South. This is attributed to competition with business and industry. To alleviate critical shortages of science teachers, it is recommended that salaries be raised to be more competitive with industry. A national database should be established to facilitate monitoring the supply of science teachers.

M6.02

AN EVALUATION OF FIELD EXPERIENCES FOR THE PREPARATION OF ELEMENTARY TEACHERS FOR SCIENCE, MATHEMATICS, AND TECHNOLOGY.

Janell D. Wilson, Livingston University, and Lawrence C. Scharmann, Kansas State University.

The purpose of this study was to evaluate the degree of self-efficacy preservice teachers developed as a result of participating in field experiences, what types of field experiences were the most beneficial for the professional development of the preservice teachers, and how well prestated outcomes were addressed by the field experiences. Data were collected by use of three instruments; the Science Teacher Efficacy Belief Inventory (STEBI), the Field Experience Evaluation Form (FEEF), and personal interviews. The STEBI was analyzed by using the Friedman nonparametric Two-way ANOVA for significance. The FEEF was analyzed using frequency distributions. The personal interviews were analyzed using comparative analyses techniques. Results of this study have produced two significant findings. First, the self-efficacy of preservice teachers increases with field experiences that are clearly defined, logically sequenced with a pattern of slow introduction into the clinical sites, and are planned for and practiced before implementation. And second, field experiences which allowed the preservice teacher to participate in small teams were found to be more beneficial to the professional development of the preservice teachers.

M6.03

LEARNING ENVIRONMENTS IN AGRICULTURAL SCIENCE CLASSROOMS: A NIGERIAN PERSPECTIVE

Suleiman Idiris, Curtin Institute of Technology and Barry J Fraser, Curtin Institute of Technology

A sample of 1,175 students and their teachers in 50 agricultural science classes at the secondary high school level participated in the first learning environment study worldwide specifically in agricultural science and one of the very few learning environment studies ever carried out in Nigeria. The particular focus of the research was the constructivistic nature of Nigerian classrooms as assessed by scales adapted from the *Constructivist Learning Environment Survey* and the emphasis on individualization as assessed by selected scales from the *Individualized Classroom Environment Questionnaire*. The study yielded numerous salient outcomes: (1) a widely-applicable instrument assessing the constructivist and individualized aspects of classroom environments was evolved and validated for future research in the Nigerian milieu; (2) past research was replicated in that associations were found between the nature of the classroom environment and students' attitudes, inquiry skills, and practical performance; and (3) an investigation of the determinants of classroom environments revealed statistically significant differences according to student gender, school location (north/south), school type (urban/rural), and the nature of the school-level environment.

M6.03

SCIENCE CLASSROOM ENVIRONMENTS IN CATHOLIC HIGH SCHOOLS: AN AUSTRALIAN PERSPECTIVE

Jeffrey P. Dorman, Australian Catholic University, Barry J. Fraser, Curtin University of Technology and Campbell J. Mc.Robbie, Queensland University of Technology

Australian Catholic church and school documents indicate that Catholic school classrooms are distinctive because of a permeating Catholic ethos. By drawing on church and school literature and the perceptions of Catholic education personnel, an instrument that assesses seven classroom environment dimensions (Student Affiliation, Interactions, Cooperation, Task Orientation, Order & Organization, Individualization, and Teacher Control) was developed. The analysis of data obtained from a sample of 2,211 Grade 9 and Grade 12 students in 104 classes (64 science, 40 religion) in 32 Catholic and Government schools (22 coeducational, 10 single-sex) attested to the instrument's validity and reliability. Using the class mean as the unit of analysis, significant differences were found between Catholic and Government schools, grade levels, science and religion classes, and gender. This study suggests that the distinctive nature of Catholic schooling does not extend to all environment dimensions deemed important to Catholic education, and that greater differences are evidenced between grade level, subject type and gender than between school types.

M6.03

INTERPERSONAL SIGNIFICANCE OF NONVERBAL BEHAVIOR OF SCIENCE TEACHERS IN LAB LESSONS: A DUTCH PERSPECTIVE

Jan van Tartwijk and Theo Wubbels, Utrecht University, Darrell Fisher and Barry Fraser, Curtin University

In previous research strong relations were found between the students' perceptions of physics teachers' communication styles and both cognitive and affective student outcomes. Data on the students' perceptions were gathered with the Questionnaire on Teacher Interaction (QTI). Subsequently the role of nonverbal teacher behavior in the teacher's interaction with the class as a group was investigated. Teachers' behaviors in short video fragments of everyday teacher-student interaction were observed. The teachers' nonverbal behavior was an important factor for the dominance-submission perception of teachers' behavior in short video-fragments and for more general evaluation of teachers' communica- tion styles as measured with the QTI. Secondly, nonverbal behavior of teachers assisting individual or small groups of students working on lab-experiments in science lessons was studied. Teacher nonverbal behavior in these circumstances was found to be important for the students' perceptions of teacher behavior and communication styles on the cooperation-opposition dimension.

M6.03

SCIENCE LABORATORY CLASSROOM ENVIRONMENTS IN CHEMISTRY:A SINGAPOREAN PERSPECTIVE

Angela Wong, Nanyang Technological University and Barry Fraser, Curtin University of Technology

This study marks the beginning of research in Singapore into science laboratory classroom environments and environment-attitude relationships. The purposes of the study were to crossvalidate the *Science Laboratory Environment Inventory* (*SLEI*) for use specifically among secondary school chemistry students in the unique milieu of Singapore, and to investigate if the nature of the chemistry laboratory environment has an effect on students' attitudes toward chemistry. The sample consisted of 1,592 students in 56 classes from 28 randomly selected coeducational government schools of similar standard. The students in every class completed actual and preferred forms of the SLEI, together with the *Questionnaire on Chemistry-Related Attitudes* (a version of the *Test of Science-Related Attitudes*). Relationships between laboratory classroom environment perceptions and attitudinal outcomes were investigated using simple , multiple and canonical correlation analyses, once using the individual student score as the unit of analysis and once using the class mean. The study attested to the validity of the *SLEI* for use in Singapore, and revealed strong positive relationships between the nature of the chemistry laboratory environment and the students' attitudes toward chemistry.

M6.04

THE RELATIONSHIP OF SUCCESS AT SCIENCE PROBLEM-SOLVING AMONG ELEMENTARY STUDENTS TO DOMAINE SPECIFIC ABILITIES ASSOCIATED WITH OUT-OF-SCHOOL EXPERIENCES AND CONTROL BELIEFS

Robert H. Evans, Wake Forest University ; Jürgen Baumert, Institute for Science Education, University of Kiel and Helmut Geiser, Institute for Science Education, University of Kiel

The purpose of this study was to examine out-of-school experiences, pupil interests and motivational factors among 517 ten-year old children in two countries and three cultures. It used identical instruments in both countries to look at environmentally acquired problem-solving skills to discover the degree to which they are domaine specific or generalizable. In addition,it measured attributions, control beliefs and interests of fourth graders to sort out their relationship to success with science problems. The eight problems used had different solution structures. Structural equation models and latent class analyses were used to clarify the complex array of correlations. Results showed that extracurricular experiences in technical domaines are necessary prerequisites for science problem-solving, but not for success on school-based science achievement tests. Also, traditional instruction in science may not compensate for a lack of out-of-school experiences when it comes to problem-solving and good problem-solvers have specific activity profiles.

M6.04

AN INTEGRATED PROFILE OF ATTRIBUTIONS, SELF-EFFICACY AND INTERESTS OF SUCCESSFUL SCIENCE PROBLEM-SOLVERS IN A CROSS NATIONAL SAMPLE OF TEN-YEAR OLD CHILDREN FROM GERMANY AND THE U.S.

Jürgen Baumert, Institute for Science Education, University of Kiel; Robert H. Evans, Wake Forest University and Helmut Geiser, Institute for Science Education, University of Kiel

The purpose of this study was to examine out-of-school experiences, pupil interests and motivational factors among 517 ten-year old children in two countries and three cultures. It used identical instruments in both countries to look at everything from television and video games to housework, fixing bicycles and play with various kinds of toys. In addition,it measured attributions, control beliefs and interests of fourth graders. The eight science problems used were mostly hands-on and with different solution structures. Structural equation models and latent class analyses were used to clarify the complex array of correlations. Results showed that students with high self-efficacy and attributions to effort, succeed more frequently on science problems and that frequency and quality of television viewing depend more in the former West Germany on attributions than on social level, whereas in the former East Germany and the U.S., television use depends more on socioeconomic level than attributions.

M6.04

A COMPARATIVE LOOK AT ELECTRONIC MEDIA HABITS AMONG TEN-YEAR OLDS IN GERMANY AND THE U.S. AS RELATED TO SUCCESS IN SCIENCE PROBLEM-SOLVING

Helmut Geiser, Institute for Science Education; Jürgen Baumert, Institute for Science Education and Robert H. Evans, Wake Forest University

The purpose of this study was to examine out-of-school experiences, pupil interests and motivational factors among 517 ten-year old children in two countries and three cultures. Prominent among these experiences was the use of electronic media. Television data was collected by having each student in both countries report each morning for two weeks what they actually watched the previous day. Structural equation models and latent class analyses were used to clarify the complex array of correlations. Results showed that the relationship between television watching time and motivational factors appears to be moderated by the high and low selectivity of the watching behavior. Thematically selective television viewing adds to general competence in problem-solving which is primarily based on everyday experiences and school learning, whereas indiscriminate television viewing and "channel-surfing" further depress already low competencies in problem-solving. High consumption of television was not associated with problem-solving success, while video game play sometimes was.

M6.05

A STUDY OF PROPORTIONAL REASONING AND SELF-REGULATION INSTRUCTION ON STUDENTS' CONCEPTUAL CHANGE IN CONCEPTIONS OF SOLUTION

Bao-tyan Hwang* and Yuan-sheng Liu
Department of Chemistry, National Taiwan Normal University

This study was to investigate the possible students conceptual changes and learning outcomes under the appropriate instruction through a teaching strategy on students' cognitive conflict. An analysis of student responses to the diagnostic pre-test and the post-test, involving conceptions of concentration and saturation of sugar solution, were reported in this paper. The two sugar solution tests and the proportional reasoning test were measured by group demonstration test method which were developed by the first researcher. These three tests were conducted on high school students selected in Taiwan area. It revealed that student conceptions of concentration were related to proportional reasoning, and that a large number of student responses focus on the ideal that sugar weight is the only factor which determined the concentration or saturation of a solution. This paper dealt with one strategy that involving experimentation and guided investigation to change student misconception and to promote their better understanding of the specific concepts related to conceptions of solutions. It was found that the strategy helped students to some extent to change their misconceptions.

M6.05

COOPERATIVE LEARNING AND INDIVIDUAL LEARNING WITH COMPUTER ASSISTED INSTRUCTION IN AN INTRODUCTORY UNIVERSITY LEVEL CHEMISTRY COURSE

Insun H. Park and Lowell J. Bethel, The University of Texas at Austin

The purpose of this study was to assess the effects of cooperative learning and individual learning with computer assisted instruction(CAI) in an university-level introductory chemistry course. The sample consisted of 109 students who enrolled in an introductory chemistry course(CH301). These students were assigned to one of cooperative learning and individual learning group with CAI and grouped in dyads within their learning abilities. They attended a lecture class first, and then worked with chemistry computer programs in the computer lab. Subjects who participated in cooperative learning performed their achievement better than subjects in the individual learning groups with computer assisted instruction(CAI) in an introductory university-level chemistry course. High-ability level students and low-ability-level students in cooperative learning group improved their performance more than high-ability or low-ability level individuals who worked alone with a computer. There was no significant difference on students' attitude between students who worked in the group use of computers and individual use of computers. The majority of the students in the university level class demonstrated positive attitude toward using computers in the classroom.

M6.05

CONVERSATIONAL THEORY AND HIGHER ORDER THINKING IN INSTRUCTIONAL CONVERSATIONS.

Jill L. Keller and Judy N. Mitchell, University of Arizona

This study examines the way tutors and students cooperated for effective information exchanges and how that cooperative effort influenced students' higher order contributions. One hundred twelve chemistry and mathematics tutorials formed the data. The tutors possessed extensive training in their subject areas and the problems were designed to make high cognitive demands on the students. Methods from discourse analysis were used to develop an analytical model to identify, describe, and compare how tutors and students exchanged information. The model was applied to the data to provide information on the roles of the tutors and students and the intellectual substance of their exchanges. Conversational theory was used to interpret the results of that analysis. Results indicated tutors and students intuitively follow a conversational code of conduct which supports their instructional responsibilities. It was found students do not contribute higher order thinking under normal instructional conditions. However, when tutors and students explicitly negotiate and accept new responsibilities for contributing higher order content to their information exchanges, then teachers can encourage students to furnish thinking of higher cognitive value to instructional conversations.

M6.05

TEACHING AND LEARNING DISTILLATION IN CHEMISTRY LABORATORY COURSES

Hanno van Keulen, Theo M. Mulder, Martin J. Goedhart and Adri H. Verdonk, Department of Chemical Education, Utrecht University, The Netherlands

The purpose of this study was to describe, explain, and (if possible) solve the problems students have when performing distillations in chemistry lab courses. Data on student performance were gathered through qualitative observation, aided by video and audio tape recordings. The curriculum structure was analysed to reveal in which contexts distillation is taught. Comparison with professional chemical contexts (purification, analysis, thermodynamics, preparation) showed that laboratory courses often do not discriminate between different contexts. This hinders communication between teacher and students. Consequently, students' decisions and teachers' remarks concerning the distillation procedure are often made with an appeal to the wrong context. New educational material (a video film and two laboratory experiments) was created in which the teaching and learning processes is correlated more consistently.

M6.06

CASE STUDIES IN VORONEZH (RUSSIA) SCIENCE EDUCATION.

Priscilla L. Callison, University of Missouri-Columbia; Jack Perna, Hunter College; Emmett L. Wright, Kay Moorman, & Don Kaur Weamer, Kansas State University; Jack Easley, University of Illinois, Champagne-Urbana; Gerald Foster, Depaul University; Monica Bradsher, National Geographic Society

Fifteen American educators met in Voronezh, Russia at the Russian - American Symposium on the Integration of Educational Systems (August 5-15, 1993). The purpose of the symposium was to develop an understanding of science education (K-11th form) in Russian schools. One symposium component was field studies of six districts within the Voronezh region. Using a case study format, six teams took rich notes of school visits and interviews. The primary focus was to describe how and what science education is within the cultural context of Russia. A secondary focus was to gather baseline data for comparisons in future documentation. General trends indicate a strong influence on the curricula from obligatory science courses, a reliance on lecture as the primary mode of science instruction, minimal use of a laboratory approach and materials, and ecology or life science as the major science of primary school.

M6.07

THE IMPACT OF CONSISTENCY AMONG EXPERT JUDGES WITHIN A NEW SCORING PROCEDURE FOR THE *VIEWS ON SCIENCE-TECHNOLOGY-SOCIETY* : A RE-ANALYSIS OF DATA

Peter A. Rubba, Christine Schoneweg and William L. Harkness, Penn State University

The purpose of the study was to examine the impact on assessment outcomes of consistency among expert judges within a new scoring procedure developed for the *Views On Science-Technology-Society* (VOSTS). The VOSTS is a pool of 115 "empirically-developed" multiple-choice items that assess beliefs about science-technology-society (STS). As originally developed and implemented, the VOSTS did not lend itself to test-retest comparisons and hypothesis testing using inferential statistical procedures. The researchers developed and previously reported on a new scoring procedure that accommodates the used of inferential statistics. A limitation of the new scoring procedure is the use of expert judges to classifying the multiple-choices under each VOSTS item as representing a view on STS interactions that is Realistic/Has Merit/Naive. In this study, descriptive statistics were used to identify a subset of the judges with consistent views. The data from the original study were re-analyzed, and both sets of findings are compared. The use of statistical procedures within the new VOSTS scoring procedure to identify a subset of judges with consistent views about STS interactions appears to warrant further examination.

M6.07

CONTESTING RATIONALITY IN STS ISSUES

P. James Gaskell, The University of British Columbia

While STS issues are seen as contentious, it is usually assumed that it is possible to "test" a person's rationality with respect to an issue by examining a person's premises and logic since the criteria for rationality in science are self-evident. Rationality is the product of correct logic and sound method. Irrationality, on the other hand is produced by conditions which distort people's perceptions or reasoning. Sociologists of science such as Bloor and Latour, however, argue that logic and rationality are not self-evident but contested. They are struggled over by groups with differing interests and values. Such a position does not mean, however, that the strength and credibility of arguments about an STS issue cannot be assessed. One way of approaching this task is by using Latour's concept of sociologics. This paper will explore some of the issues related to rationality and the possibility of using Latour's sociologics to assess the strength and credibility of STS arguments. It will draw on data from student interviews about socioscientific issues gathered as part of the BC science assessment and discuss some implications for science teaching.

M6.08

LA INTERDISCIPLINARIEDAD COMO EJE DE LA DIDACTICA EN LA BIOLOGIA CELULAR Y MOLECULAR

Norma Constanza Castaño Cuellar, Francia Cabrera Castro, y William Mora Penagos, Universidad Pedagógica Nacional. Colombia

La pedagogía muestra en su acción una separación entre el discurso científico y la didáctica. En el caso de la Biología Celular y Molecular no hay coherencia entre la estructura explicativa y la forma como la didáctica la presenta a los estudiantes: encontramos una tendencia a la compartimentación y utilización exclusiva de los procedimientos analítico-reduccionistas, y observamos en los estudiantes la tendencia a partir de las mismas denominaciones, pero los códigos y representaciones son antagónicos y no complementarios con los conceptos científicos. Se propone orientar la didáctica de acuerdo con las formas como se ha abordado la construcción del discurso disciplinar, lo cual exigiría una perspectiva de tipo globalizador para mejorar las condiciones de aprendizaje en el aula, de posibilitar una visión y un modo de trabajo didáctico que amplie los horizontes en la acción de los docentes, pues estos deben transformar su función hacia la constitución de un verdadero saber pedagógico y establecer las relaciones fundamentales entre la acción e la enseñanza como elemento de distribución de saberes y como posibilitadora de pensamiento en saberes específicos.

M6.08

LA CONCEPTUALIZACION DE PROBLEMAS EN QUIMICA
Edgardo R. Donati, J.J. Andrade Gamboa, y Daniel O. Martire, Universidad Nacional de La Plata, Argentina

Los procesos de enseñanza-aprendizaje de las ciencias suelen detenerse antes de la etapa de conceptualización. A fin de alcanzar de alcanzar dicha etapa resulta necesario inducir al alumno a una actitud independiente, quebrando la costumbre de resolución por imitación del problema tipo. Esto puede lograrse mediante las llamadas etapas de elaboración, una de cuyas variantes presentamos en este trabajo: se trata de extender los conceptos a través de la generación y/o de la interpretación de gráficos. Exponemos ejemplos para los temas de estequiometría y equilibrio químico.

M6.09

AN ANALYSIS OF LEARNING ENVIRONMENTS IN HIGH SCHOOL SCIENCE CLASSES
Campbell McRobbie, Queensland University of Technology.
Kenneth Tobin, Florida State University.

This study aimed to construct a greater understanding of the manner in which teachers and students make sense of teaching and learning through an investigation of the learning environments in high school science classes. An interpretive methodology incorporating a constructivist perspective was utilised. Researchers visited classrooms, interviewed selected students and teachers and surveyed students and teachers perceptions of their experienced and preferred perceptions on five dimensions of the learning environment: involvement of students in discussion, autonomy of students in making decisions about learning, relevance of the science studied, commitment of students to learning and inhibitors of learning. Six cultural myths seemed to have a strong influence on the way the teachers and students enacted the curriculum and these myths led to a disempowering of both teachers and students with respect to the curriculum. While different teachers perceived their classroom to have differing learning environments, students and teachers tended to see the environments in particular classes in similar ways which has implications for the impetus for change.

M6.08

MODELOS PARCIALMENTE POSIBLES SOBRE CONCEPTOS BASICOS EN GENETICA
C. L. Gallegos, F. C. Flores, S. M. E. Jerezano, y Z. C. Alvarado, Centro de Instrumentos, Universidad Nacional Autónoma de México, México

A partir de la perspectiva de la Epistemología Estructural de Sneed, se analizan las ideas de estudiantes del Bachillerato sobre los conceptos genéticos de: a) herencia de características heredadas; b) transmisión de caracteres; c) representación de cromosomas; d) manejo de conceptos básicos y e) resolución de problemas en cruzas monohíbridas. Para el análisis se hacen corresponder los modelos parcialmente posibles con los modelos de los estudiantes. Los modelos de los estudiantes son el resultado de la aplicación de un cuestionario con 24 reactivos que fue aplicado a 342 estudiantes pertenecientes a escuelas de educación media superior de la Universidad Autónoma de México. Comparando los modelos parcialmente posibles de los estudiantes con el modelo científico se pueden observar importantes diferencias entre ellos.

M6.09

RELATIONSHIP BETWEEN EARTH SCIENCE EDUCATION AND SPATIAL VISUALIZATION
Nir Orion, David Ben-Chaim, and Yael Kali
Weizmann Institute of Science, Israel

The purpose of this study was to look for interrelations between the study of an introductory course to geology and the development of spatial visualization ability. The study was conducted among 32 undergraduate students during their first year of earth sciences study in the Hebrew University of Jerusalem. The students' spatial visualization memory was measured at the beginning and at the end of the course by two different validated existing instruments. Pre and post scores were posted for any significant change and for correlation with students' final score of the course. Results indicated that the students' spatial visualization ability was significantly improved following the first year of studying earth sciences and without any specific training program. A correlation between spatial aptitude and achievement in the geology course was found as well. Interviews revealed that the students claimed that only the earth sciences' courses required spatial visualization skills. It is suggested that there is a two-way relationship between studying of earth science and spatial visualization skills. It seems that studying earth science itself might improve students' spatial visualization aptitude. The findings also support the notion about sex differences favoring males in relation to spatial visualization.

M6.09

A SURVEY OF THE SCIENCE LEARNING ENVIRONMENTS IN FLORIDA'S SCHOOLS.
Kenneth L. Shaw, Connie Stark, Kenneth G. Tobin, Florida State University

The purpose was to examine the learning environments in science classrooms in Florida. Surveys determined how teachers and students responded to categories of autonomy, participation, relevance, commitment, and disruption. Twenty-three schools and 669 students representing Florida's diverse population took part in the study. Noted, were differences between teachers' and students'; K-12 teachers believe there was more participation occurring and the subject was more relevant than what students believe, K-12 students had a much higher commitment and more autonomy to learn than what the teachers' perceived. As students progress from elementary through the high school science classes, their commitment is lower and science is perceived as less relevant.

M6.10

AN INTERNATIONAL INVESTIGATION OF PRESERVICE SCIENCE TEACHERS' PEDAGOGY AND SUBJECT MATTER KNOWLEDGE STRUCTURES
Norman G. Lederman, Oregon State University, and Huey-Por Chang, National Changhua University of Education

The nature/development of an international sample of preservice science teachers' subject matter and pedagogy knowledge structures as they proceeded through student teaching was assessed. Twelve U.S. and 14 Taiwan preservice science teachers were asked to create representations of their subject matter and pedagogy knowledge structures before and after student teaching and participate in a videotaped interview concerning the knowledge structures immediately following student teaching. Qualitative analyses of knowledge representations and transcribed interviews within and between subjects were performed. Initial knowledge structures were typically linear and not coherent. Subject matter representations were stable, while pedagogy structures were susceptible to change, in the U. S. sample, as a consequence of teaching. The U.S. preservice teachers perceived pedagogy and subject matter as distinct and exerting separate influences on classroom practice, while the Taiwanese sample consistently exhibited difficulty in separating subject matter from pedagogy. Implications concerning cultural differences, interaction of knowledge structure complexity and translation into classroom practice, and the advocacy for increasing subject matter backgrounds of preservice teachers are discussed.

M6.10

A PRELIMINARY REPORT ON TEACHER CHARACTERISTICS AFFECTING PROCESS SKILLS AND CONTENT KNOWLEDGE IN MOLECULAR BIOLOGY
Rosalina Hairston and Catherine Cotten, University of Southern Mississippi

Biology teachers in a four week summer institute on cell and molecular biology were administered THE TEST OF INTEGRATED PROCESS SKILLS(TIPS), a content test on cell and molecular biology(CMBT), and the SCHOOL-LEVEL ENVIRONMENT QUESTIONNAIRE (SLEQ). There was a significant difference between the pre and post-test of the TIPS and the CMBT. A Pearson correlation of 0.8233 was obtained between the post-test scores of the TIPS and CMBT. A correlation (0.7114) between the professional interest sub-scale of the SLEQ and the CMBT post-test score was found. Multiple correlation analysis indicated the following positive relationships: (1) criterion variable of TIPS post-test score and the predictor variables of years teaching and CMBT post-test score, (2) criterion variable of CMBT post-test score and the predictor variables of years teaching and TIPS post-test score, (3) criterion variable of TIPS post-test score and the predictor variables of college biology courses and CMBT post-test score, (4) criterion variable of CMBT post-test score and the predictor variables of TIPS post-test score and college biology courses.

M6.10

APPRENTICESHIP TEACHING: ASSISTING PRE-SERVICE ELEMENTARY TEACHERS IN DEVELOPING A COGNITIVE FRAMEWORK FOR SCIENCE CONTENT REPRESENTATION AND INSTRUCTION
Carla M. Zembal, Joseph Krajcik, Phyllis Blumenfeld and Annemarie Palincsar, The University of Michigan

The purpose of this study was to examine what pre-service elementary teachers come to understand regarding goals, science content representation and instruction as a result of participating in instructional cycles of planning, enacting and reflecting. We refer to this as apprenticeship teaching, the goal of which is to assist students in developing a framework for identifying and addressing relevant considerations in planning and enacting effective science instruction. Students participated in collaborative efforts to plan integrated lessons around a unit, engaged in interactive instruction with peers and reflected on enactments during debriefing discussions. An analysis scheme derived from the literature was used to identify patterns in the data from all phases of the instructional cycle. Results indicate that apprenticeship teaching can assist pre-service teachers in developing a way of thinking about issues associated with effective science instruction, particularly selecting and justifying goals and representing science content. Comparisons of patterns in the enactment and debriefing data suggest that changes in enactments are closely linked to the pre-service teachers' understandings constructed during debriefing discussions.

M6.17

POSTMODERNISM AS A RESOURCE FOR SCIENCE EDUCATION?
Nancy Brickhouse and Sandra Harding, University of Delaware; Ron Good, Louisiana State University; Jay Lemke, City University of New York

Many perspectives on postmodernism in the arts, humanities, and social sciences have been expressed by supporters and critics of this movement. What is postmodernism and what does it have to say to those of us interested in science education research? This question will be the focus for discussion in this symposium. Of concern to many scientists and science educators is the relativist epistemology of science that appears to be at the center of postmodernism. Science For All Americans, for example, defines the nature of science in clearly nonrelativist terms. How might postmodern critiques assist in the reform of science education? Is postmodernism anti-science? Even if postmodern critiques are seen to have little value to the enterprise of science, can science education and related research benefit from a careful study of issues central to this movement?

M7.01

THE EMERGENCE OF SCIENCE EDUCATION RESEARCH AS AN INTERNATIONAL ENTERPRISE.
John R. Sode, North Dakota State University
John Settlage, Jr. Cleveland State University
Hsiao-Ching She, National Taiwan Normal University

The growth of an active international membership within NARST suggests the existence of global centers of science education research. This study was designed to test this hypothesis by examining researchreports from North America and Taiwan (Republic of China). Articles from randomly selected issues of JRST and Science Education (1991-1992) and The Proceedings of the National Science Council, Republic of China (Taiwan (1991-1992) were first categorized according Pollard et al.'s1993 classification scheme. Activity levels, represented by percentage of coverage, were then established for North America and Taiwan. Examination of the results revealed that, in terms of percent coverage, the two regions were focusing on different aspects of science education. These differences suggest that science education research activity is global in nature.

M7.01

CONSTRUCTIVISM IN ONE COUNTRY: THE NEW ZEALAND EXPERIENCE
Michael R. Matthews, University of New South Wales

This talk will trace the development of constructivist thinking in New Zealand science education from its origins in the late 1970s as a theory of children's learning, and expressed in the Roger Osborne & Peter Freyberg book *Learning in Science* (Heinemann 1985), into a full-fledged theory of knowledge, of curriculum, of teaching and of education, that in the early 1990s has informed the development of the country's national science curriculum. Some strengths and weaknesses of the doctrine will be noted, especially the constructivist *non sequitur* problem of moving from a learning theory to a curriculum theory, an educational theory or to an epistemology.

Attention will be drawn to the mixed educational and cultural consequences of using constructivism to inform science curriculum decisions at a national level.

M7.03

INVESTIGATING THE VALIDITY OF HANDS-ON PERFORMANCE ASSESSMENT IN SCIENCE
Anthony W. Bartley, The University of British Columbia

Performance assessment in science represents an area of significant growth. As this form of assessment becomes more widely used, questions of validity become more important. This study will identify and use a set of procedures for the examination of the validity of a large-scale performance assessment in science. The data collected as part of the Student Performance Component of the 1991 B.C. Science Assessment, together with the inferences presented in the **Technical Report** (Erickson, Bartley, Blake, Carlisle, Meyer and Stavy, 1992) and the consequences of the assessment will be investigated. Analytical procedures encompass both qualitative and quantitative research methods. The conclusions set out the implications of the use of performance assessment tasks in large-scale assessment programs.

M7.03

DEVELOPMENT AND VALIDATION OF A CURRICULUM THEORY-BASED CLASSROOM ENVIRONMENT INSTRUMENT.
Craig W. Bowen, University of Washington.

The study describes the development of a learning environment instrument based on a social-interactionist conception of curriculum. A draft instrument consisting of six curricular dimensions for three underlying cognitive interests (Technical, Practical, and Emancipatory) were administered to roughly 300 students in various university-level science courses. The resulting survey data were analyzed in terms of reliability estimates for the scales, interscale correlations, and class-based discriminant validity. The survey data were also factor analyzed to examine item-scale structures. Based on these analyses the final version of the learning environment instrument was developed. One use of the instrument was illustrated by highlighting the curricular experiences of students in a college chemistry class for non-majors.

M7.04

CURRICULUM REFORM: HIGH SCHOOL INTEGRATED SCIENCE
Ronald D. Anderson, University of Colorado

This case study of a West Coast high school initiating an integrated science program -- one of several cases in a national study of curriculum reform -- is designed to acquire an understanding of both the substance of the reform and the means by which the reform was put in place. Data is acquired primarily through (1) observation of classes and other school events, (2) interviews with individuals such as students, teachers and administrators, and (3) analysis of documents. The analysis produces descriptive and interpretive portrayals that address questions about influences, results and dilemmas within the following dimensions: (1) personal, (2) interactional, (3) contextual, and (4) historical. Implications are drawn for schools entering into science curriculum reform.

M7.03

RELIABILITY OF PERFORMANCE-PORTFOLIO ASSESSMENT: PEER AND INSTRUCTOR GRADING
Gilbert L. Naizer, Ohio State University

The purpose of this study is to evaluate the reliability of using peer grading of performance-portfolios in an elementary methods course. Peer grading, although suggested by some as a teacher time- saving device, is controversial. The percentage agreement of scoring among peers and instructors was examined in two subsequent semesters of the course. The results of this study indicate that performance-portfolios can be reliably and consistently graded by students.

M7.04

CURRICULUM REFORM: A NEW MIDDLE SCHOOL CURRICULUM PACKAGE
Kathleen Davis and Ronald D. Anderson, University of Colorado

This case study of a Midwestern middle school implementing one of the new NSF-funded science curriculum programs -- one of several cases in a national study of curriculum reform -- is designed to acquire an understanding of both the substance of the reform and the means by which the reform was put in place. Data is acquired primarily through (1) observation of classes and other school events, (2) interviews with individuals such as students, teachers and administrators, and (3) analysis of documents. The analysis produces descriptive and interpretive portrayals that address questions about influences, results and dilemmas within the following dimensions: (1) personal, (2) interactional, (3) contextual, and (4) historical. Implications are drawn for schools entering into science curriculum reform.

M7.04

CURRICULUM REFORM: MIDDLE SCHOOL INTEGRATED SCIENCE

Joan Whitworth and Ronald D. Anderson, University of Colorado

This case study of an East Coast middle school initiating an integrated science program -- one of several cases in a national study of curriculum reform -- is designed to acquire an understanding of both the substance of the reform and the means by which the reform was put in place. Data is acquired primarily through (1) observation of classes and other school events, (2) interviews with individuals such as students, teachers and administrators, and (3) analysis of documents. The analysis produces descriptive and interpretive portrayals that address questions about influences, results and dilemmas within the following dimensions: (1) personal, (2) interactional, (3) contextual, and (4) historical. Implications are drawn for schools entering into science curriculum reform.

M7.05

STUDENTS' RANKING OF AND OPINIONS ABOUT THE STANDARDS OF LEARNING IN NIGERIAN SCIENCE EDUCATION PROGRAM.

Olugbemiro J Jegede, Distance Education Centre, University of Southern Queensland, Toowoomba, Australia and Peter A O Okebukola, Faculty of Education, Lagos State University, Nigeria

The purpose of this study was to investigate how post-secondary school science education students rank some identified science education program standards as well as seek their opinions regarding their perception of the desirability and achievement of the standards in Nigeria. 265 final year science education students in 10 randomly selected Colleges of Education participated in the study. The Science Education Program Assessment Model (SEPAM) containing 13 identified program standards of science education was used for data gathering. The instrument developed for use in Virginia State science education and adapted for the Nigerian situation was found to be highly reliable using the test-retest procedure ($r=0.92$) and the Kuder-Richardson 20 formula ($r=0.90$). The results indicated that 'encouraging students to become self-directed learners' and 'emphasizing the utilization of scientific values' were prioritized as first and last respectively. Paired t-test comparing opinions of the students about standards desirability and achievement indicated significant differences at $p<.01$. No significant gender differences were found in the sample's perception of the desirability and achievement of the science education program standards in Nigeria.

M7.05

MULTI-STATE SURVEY OF RURAL SECONDARY SCIENCE TEACHERS' PERCEIVED NEEDS

William E. Baird, Auburn University; J. Preston Prather, University of Virginia; Kevin Finson, Western Illinois University; and J. Steve Oliver, University of Georgia.

Research supports the idea that rural schools are unique, but few programs prepare teachers for the rural teaching arena. A review of studies on rural teaching revealed some characteristics of rural science education, but no single study was found that examined rural science teachers' needs over a broad geographic and demographic area using a single survey instrument. To build such a data base, a group of science educators designed a 100-item instrument to assess teachers' needs and teaching patterns, obtain demographic data on teacher and school variables, and solicit responses to problems confronting science teachers. Teachers in eight states across the nation were surveyed. A total of 2,414 usable surveys were returned; and the data were processed for each state and also pooled to provide a broad perspective of teachers' perceived needs. The study provided much information on similarities and differences among rural and non-rural teachers' perceived needs and priorities. This information is important to educational policy makers and pre- and inservice teacher educators.

M7.05

KNOWLEDGE AND ATTITUDES TOWARDS AREA OF SPECIALIZATION OF STUDENTS IN TEACHER TRAINING PROGRAMS

L. Linchevski, Hebrew University, Israel, S. Ziv, M.O.F.E.T., Israel, P. Tamir, Hebrew University, Israel, and D. Livne, Teachers College, Israel

The aim of the study presented here was to find answers to two main questions: (1) What knowledge do student teachers who specialize in mathematics and science possess in their main subject of specialization? (2) What attitudes and beliefs are held by student teachers regarding their main subject matter of specialization? The study followed the design of a similar study carried out at the University of Exeter, U.K. It was conducted between 1990 and 1992 and involved 337 Israeli students studying in academic and nonacademic colleges, in their third or fourth year of study towards qualifying to teach in either elementary or junior high school. The knowledge of mathematics contained three sub-variables, general knowledge of mathematics, ways of forming mathematical knowledge, students' misconceptions regarding mathematics, while the knowledge of science contained two groups of sub-variables, subjects of science (basic science skills, biology, physics, chemistry) and levels of thinking (level of knowledge, level of understanding, high levels of thinking). The results show that in all sub-variables and in the total scores the students in the fourth year score higher than those in the third year; also, students in the junior high track score high than those in the elementary school track. When it comes to basic skills in science and general knowledge in mathematics, the differences are smaller. There was no correlation between attitudes and knowledge, neither were there significant differences in attitudes between tracks.

M7.06

IMPROVING ELEMENTARY SCIENCE TEACHING THROUGH COLLABORATIONS: ISSUES OF POWER IN UNIVERSITY/SCHOOL RELATIONSHIPS.

Michael T. Hayes, University of Utah

The purpose of this study was to investigate how power inequities can effect collaborations between university researchers and classroom teachers. Recent research on university/public school collaborations have overlooked historically derived power inequities which can infiltrate even the best collaborative intentions. This was a year long study undertaken at a local elementary school. Ethnographic techniques such as field notes, participant observation and interviews were used to collect data. Analysis of the data indicates that attempts by the participants to overcome or acquiesce to institutionally derived power inequities were central in the development of collaborative relationships. This served to undermine the potential positive effects of the partnership.

M7.06

ROLES, INTERACTIONS, AND MENTORING STYLES OF TEACHER SUPPORT TEAM MEMBERS IN A MIDDLE GRADES SCIENCE TEACHER INDUCTION PROGRAM

John R. Wiggins, Georgia Institute of Technology

The purpose of this study was to explore the roles that the Teacher Support Team (TST) members assumed in a beginning middle grades science teacher induction program, investigate the interactions between members of the TST, and characterize the mentoring style of the interactions used in providing support to three beginning science teachers. The TST included three members: (1) a school-based teacher (internal mentor); (2) a university resource person (external mentor); and, (3) a beginning science teacher. This program only matched beginning science teachers with mentors who were experienced science educators. Findings indicate an effective induction program to assist beginning teachers should include: multiple sources of support; financial support for all members of the TST; support for the beginning teachers instead of evaluation; careful matching of mentors and beginning teachers by grade level and content areas; and, scheduled time for interactions between TST members. Based upon the results of this study and other studies about induction, beginning teachers should be supported as they make the transition from preservice education to experienced teacher.

M7.06

THE IMPACT OF LEADERSHIP DEVELOPMENT ON PERCEPTIONS OF THE ELEMENTARY LEAD SCIENCE TEACHER ROLE.

Catherine R. Nesbit and Josephine D. Wallace, University of North Caroline at Charlotte

The purpose of this study was to examine the concerns and perceptions of the lead science teacher role as twenty-two elementary teachers progressed through a year and a half leadership development program at the University of North Carolina at Charlotte. The participants' concerns and perceptions were measured at four intervals using the Stages of Concern Questionnaire *(SoCQ)* and the Focus Group Interview technique. Principals' perceptions were gathered two times during the program using the Focus Group Interview. Additionally, lead teachers from two of the eleven project schools, their principals, and randomly selected teachers were individually interviewed regarding their perceptions of the role near the conclusion of the program. *SoCQ* results indicated a decreased level of concern about being a lead science teacher during the program in all categories except Awareness and Collaboration. Focus Group Interview data revealed changes in the way lead science teachers and their principals viewed leadership. Their perceptions shifted from a responder role to an initiator role and from a more autocratic role to a more democratic role. Individual interviews indicate lead teachers, principals, and other teachers generally perceive the lead teacher as a resource person.

M7.07

CHANGES IN STUDENTS' UNDERSTANDING OF EVOLUTION RESULTING FROM DIFFERENT CURRICULAR AND INSTRUCTIONAL STRATEGIES

Murray Jensen and Fred Finley, University of Minnesota

This study assessed students' learning of evolution by natural selection within four different sections of an introductory biology course. Each section used a different combination of curricular materials (either traditional or historically-rich materials) and instruction (either paired problem solving or traditional lecture). Students in the study completed pre and post intervention evolution tests. Students' responses were analyzed to create variables for both correct and incorrect conceptions of evolution by natural selection. Pretest and posttest data were used to create difference scores that were compared both within and between teaching sections. Pretests to posttest differences within each section showed gains in correct understanding but few reductions in misunderstanding. No differences were found between sections in either the curricular or instructional comparisons. Results indicated that students' misunderstandings related to Lamarckian evolution to be more resistant to change than any other type identified.

M7.07

THE EFFECT OF BACKGROUND MUSIC ON STUDENT MOTIVATION IN AN INTRODUCTORY COLLEGE BIOLOGY LABORATORY

Shawn Mueske, Wilmar Community College and D. Daryl Adams, Mankato State University

This study investigated the effects of background music on student motivation. 218 students enrolled in a non-major introductory college biology course participated in the one quarter study. All laboratory sessions were conducted in two identical laboratory rooms -- one with background music and the other without. Students motivation in the laboratory was measured by assessing individual student's attitude towards the laboratory, academic achievement in the course, time spent in the laboratory sessions, and time-on-task while in the laboratory. Statistical analysis showed no difference ($p<.05$) in attitude towards laboratory or in academic achievement. Statistical analysis indicated that the students participating in the sessions with background music spent more time in the laboratory and had a higher on-task ranking than their non-music counterparts ($p<.05$).

M7.08

PROGRAMA REGIONAL DE CIENCIA Y TECNOLOGIA JUVENIL

Jorge Bueno, y Nelly Díaz, Ministerio de Educación y Cultura del Uruguay, Uruguay

COPAE L.A. es una organización estructurada a partir de UNESCO la que participan siete paises: Argentina, Brasil, Bolivia, Chile, Paraguay, Peru y Uruguay. Con el apoyo de un número significativo de instituciones nacionales e internacionales se planifica cada año un "Programa internacional de ciencia y tecnología juvenil", que permite a los jóvenes de la región, compartir sus trabajos de investigación.

M7.07

A CROSS AGE STUDY ABOUT INSECT METAMORPHOSIS: ESCAPING ROTE BIOLOGY,

M. Susan Nichols and James H. Wandersee
Louisiana State University

The purpose of this study was to analyze the nature of public school students' alternative conceptions about insect metamorphosis (as identified in grades 5, 7, 9, and 11) and to suggest ways of teaching this common science curriculum topic meaningfully. Data gathered via sequencing illustrations of both types of metamorphosis, drawing concept circle diagrams about metamorphosis, and responding to live-insect-based clinical interviews were integrated to yield the following findings: (a) students very seldom gave evolutionary explanations or ecological advantages for the existence of insect metamorphosis; (b) their science texts presented insect metamorphosis in ways that encouraged rote learning; (c) graphic probes (illustrations, students' self-constructed concept circle diagrams) revealed prior knowledge about insect metamorphosis that semantic-oriented questioning masked– due to the interviewee's unfamiliarity with (or confusion of) concept labels; (d) none of the students evidenced any biological understanding of how insect metamorphosis occurs--viewing it as almost magical; and (e) although students' understanding of insect metamorphosis grew as they moved through school, out-of-school learning experiences appeared to explain much of that cognitive growth.

M7.08

POSTGRADO EN BOVINOS DE CARNE: UNA OPCION PARA LA ZONA MAR DE CORTEZ

Rafael de Luna de La Peña, C. H. Hernández, V. J. Espinoza, H. A. Palacios, Universidad Autónoma de Baja California Sur, México

La zona Mar de Cortez comprende los estados de Baja California Sur, Baja California, Sinaloa, Sonora y Nayarit, localizados en la parte noroeste de la república mexicana, en cada uno de los cuales existe por lo menos una institución de Educación Superior donde se ofrecen diferentes opciones curriculares de postgrado, sin embargo en ganadería, solo en el Instituto de Investigaciones en Agricultura y Ganadería de la Universidad Autónoma de Baja California existe la posibilidad de realizar estudios de postgrado ofreciendose la maestría en sistemas de producción animal con dos opciones, una es producción de carne y la otra es producción de leche, razón por la cual se plantea la creación del postgrado en bovinos de carne con cuatro opciones terminales: Nutrición, Reproducción, Manejo de Pastizales y Administración. El plan de estudios está disañado para cursarse en dos años, el primero es un tronco común con 10 materias, al final de este se elige una de las opciones terminales, cada una con ocho materias, se exige además la presentación de un programa especial de investigación y la elaboración de una tesis. La línea prioritaria de investigación es el desarrollo de la producción de carne de bovinos en zonas áridas.

M7.08

EXTENSION AGROPECUARIA: UNA EXPERIENCIA FUNDAMENTAL EN EL PRINCIPIO PEDAGOGICO DEL TRABAJO

R. Santos, Universidad Autónoma de Baja California Sur, México

Aborda la educación rural a través de la Extensión Universitaria (Función sustantiva) como vínculo de la universidad con la sociedad, a través de un centro piloto de producción, investigación y extensión agropecuaria en la producción avícola de pollo de engorde y gallina de postura por un grupo de mujeres campesinas en la comunidad ejidal de El Pescadero Baja California Sur.

M7.09

EXPLORACION Y ANALISIS DE LAS CONCEPCIONES Y ACTITUDES DE LOS DOCENTES DE FISICA A NIVEL DE ENSENANZA MEDIA BASICA Y PROPUESTA DE NUEVAS ALTERNATIVAS METODOLOGICAS

Clare Elvira Camargo, Eduardo Zalamea Godoy, y Jorge Enrique Zamora Guevara, Universidad Nacional de Colombia, Colombia

Así como existen obstáculos epistemológicos que dificultan la construcción del conocimiento científico de los alumnos, también existen preconcepciones y prejuicios solidamente arraigados en los profesores que les impiden ver la necesidad de modificar su quehacer docente en una dirección tal que propicie el mejoramiento cualitativo de la enseñanza de las disciplinas correspondientes. Esta investigación se plantea como una instancia dentro del aula de modo tal que el profesor 1. Cobre conciencia de la necesidad de reorientar su quehacer a partir de su interacción. 2. Se disponga a recibir la capacitación adecuada mediante una sólida fundamentación en, cuanto menos, tres niveles a saber: Teórico-Disciplinario, Epistemológico y Metodológico.

M7.09

ENSENANZA DE LA QUIMICA EN LA EDUCACION SECUNDARIA

Dagoberto Cáceres Rojas, y José Muñoz Castillo, Universidad Nacional de Colombia, Colombia

Desde hace varios años se ha hecho evidente la necesidad de una interacción real y efectiva entre las etapas de formación media y universitaria en las Ciencias Naturales y específicamente en la Química. Estas etapas han estado tradicionalmente aisladas en su programación y desarrollo. A través de cursos de actualización programados por la universidad, estas instancias han venido acercándose desde hace varios años y se han diseñado alternativas de trabajo que se aplican en este proyecto. Este trabajo busca alcanzar una formación conceptual y experimental de los profesores de secundaria acorde con los tiempos modernos, que les permita ser autónomos y creativos en el desarrollo de su tarea.

M7.09

ENSENANZA DE LA BIOLOGIA EN LA EDUCACION SECUNDARIA

Angela Chaparro de Barrera, y Martha Orozco de Arnézquita, Universidad Nacional de Colombia, Colombia

La investigacin sobre la enseñanza de la Biología en Colombia no se ha realizado de manera ordenada ni sistemática. Las evaluaciones efectuadas señalan: a) Insuficiente saber de los maestros en cuanto a métodos, desarrollo histórico y social, y aspectos básicos de la disciplina. b) Posibilidad de mejorar los métodos de la enseñanza de la Biología motivando a los maestros con talleres de capacitación que se alejen del esqueema rutinario y repetitivo tendiente a mitificar la ciencia y en el que poco se tiene en cuenta el quehacer del docente en el aula.

M7.09

PROYECTO UNIVERSITARIO DE INVESTIGACION: ENSENANZA DE LAS CIENCIAS

José Gregorio Rodríguez, Universidad Nacional de Colombia, Colombia

El proyecto universitario de investigación: Enseñanza de las Ciencias es un macroproyecto que pretende explorar y desarrollar alternativas de enseñanza en las diversas áreas del conocimiento con el fin de mejorar la calidad de la educación a partir de las disciplinas mismas, generando una cultura académica en la escuela que fomente la racionalidad científica y la producción crítica del conocimiento. El proyecto desarrolla programas deformación de docentes en servicio de diversos niveles de la educación involucrándolos en procesos sistemáticos de producción de conocimiento pedagógico con miras a realizar cambios en las práticas educativas. Participan 27 profesores de la Universidad Nacional de Colombia quienes trabajan con una concepción multidisciplinaria en 15 subproyectos que cubren los campos de Lenguaje, Literatura y Lenguas Extranjeras; Matemática y Ciencias Naturales; Filosofía y Ciencias Socialesy Salud.

M7.11

THE NOTION OF INTERDISCIPLINARY STUDIES AS A FOCAL POINT FOR THE TEACHING OF CELLULAR AND MOLECULAR BIOLOGY

Norma Constanza Castaño Cuellar, Francia Cabrera Castro, y William Mora Penagos, Universidad Pedagógica Nacional, Colombia

Spanish abstract may be found under session number M6.08.

M7.11

TEACHING METHODS USED BY PROFESSORS OF SCIENCE TO DEVELOP CRITICAL THINKING

Deyanira Barnett, y Lydia de Isaacs, Lydia, Universidad de Panamá, Panamá

Spanish abstract may be found under session number M4.08.

M7.11

LEGACY OF RESEARCH IN PERUVIAN UNIVERSITIES

Esteban Castellanos, Universidad Católica del Perú, Perú

Spanish abstract may be found under session number S4.08

M7.11

THE CONCEPTUALIZATION OF CHEMICAL PROBLEMS
Edgardo R. Donati, J.J. Andrade Gamboa, y Daniel O. Martire.
Universidad Nacional de La Plata, Argentina

Spanish abstract may be found under session number M6.08.

M7.11

STAGES IN ALTERNATIVE CONCEPTIONS OF MOTION: A COMPARISON OF RESPONSES IN THREE COUNTRIES.
Shulamith Graus Eckstein, Maria Kozhevnikov and
Tehila Lesman, Technion-Israel Institute of Technology
Michal Shemesh Lomask,
Department of Education, State of Connecticut

A systematic study of children's ideas of motion was carried out in three countries: Israel (N=631), England (N=383) and Australia (N=357). A four-part questionnaire about motion was administered to pupils from Grade 2 to Grade 12 (ages 7 to 18). The responses were categorized according to level of sophistication. The responses of the children in England were very similar to those in Australia; but there were significant differences in their responses from those of Israeli children. In some cases, the differences favored the Australians and English, and in other cases they favored the Israelis. For three of the questions, it appears that children pass through distinct, successive stages with respect to their conceptual understanding. A mathematical model was developed which gives the proportion of children in each stage as a function of age. It predicts that the proportion of subjects at each stage is a linear combination of decreasing exponentials, and it fits the data well.

M7.11

INDUCED MISCONCEPTIONS IN THE TEACHING OF CHEMISTRY
Edgardo R. Donati, Daniel O. Martire, y J.J. Andrade Gamboa.
Universidad Nacional de La Plata, Argentina

Spanish abstract may be found under session number S6.08.

M7.11

CONCEPTUAL NETWORKS. PART I: FUNDAMENTAL THEORY
Lydia Galagovsky, Universidad de Buenos Aires, Argentina

Spanish abstract may be found under session number S6.08.

M7.11

CONCEPTUAL NETWORKS, PART II: PHYSICS THEMES AS APPLICATION EXAMPLES FOR MIDDLE LEVEL
Lydia R. Galagovsky, y Nora Ciliberti, Universidad de Buenos Aires, Argentina

Spanish abstract may be found under session number M4.08.

M7.11

THE RELATIONSHIP BETWEEN STUDENTS MOTIVATIONAL PATTERNS AND INSTRUCTIONAL STRATEGIES IN SCIENCE TEACHING
Avi Hofstein, The Weizmann Institute of Science, Israel.
Geoffrey Giddings and Bruce Waldrip, SMEC, Curtin University of Technology, Australia

During the last decade, much attention has been drawn to the cognitive aspects of students' characteristics but little attention has been given to the motivational aspects of science education. This paper describes a study conducted in Israel and Australia in different educational settings and in different science subjects. Four typologies of students were identified as having different preferences for particular instructional strategies, namely the "curious", the "achiever", the "conscientious" and the "social". The results indicate that not only an interrelationship exists between students' preferences for particular instructional strategies and their motivational profile but there are also patterns relating to the subject itself. In particular, differences were observed regarding Biology and Physics curricula.

M7.11

POSSIBLE PARTIAL MODELS ABOUT GENETICS BASIC CONCEPTS
C. L. Gallegos, F. C. Flores, S. M. E. Jerezano, y Z. C. Alvarado, Centro de Instrumentos, Universidad Nacional Autónoma de México, México

Spanish abstract may be found under session number M6.08.

M7.11

PRECONCEPTS AND THEIR REPRESENTATION IN BASIC CONCEPTS OF GENETICS
S. M. E. Jerezano, Z. C. Alvarado, C. F. Flores, C. L. Gallegos, Universidad Nacional Autónoma de México, México

Spanish abstract may be found under session number S6.08.

M7.11

TEACHING STRATEGIES, STUDENTS' CLASSROOM LEARNING ENVIRONMENT AND STUDENTS' CHOICE OF AN ADVANCED COURSE IN HIGH SCHOOL CHEMISTRY.

Avi Hofstein, Weizman Institute of Science, Rehovot, Smadar Avishay and Reuven Lazarowitz, IIT Technion, Haifa, Israel

The purpose of this study was to investigate the relationships between teaching strategies, classroom learning environment and students' attitudes, and students' choice of an advanced course in chemistry. The sample consisted of five chemistry teachers and 278 students from the 10th, 11th, and 12th grades. Students from the 11th and 12th grades learned chemistry at the 3 and 5 points level for the matriculation exams. Teachers' strategies were observed in the class and laboratories. Each teacher was observed in nine consecutive periods. Based on the observations, a teaching profile was constructed related to five strategies: a) teaching style; b) teacher-student interaction; c) teaching of concepts; d) cognitive level of teachers' questions; and e) teachers' reactions to students. Results show significant positive correlations 1) between current topics taught and previous knowledge, and 2) between diversification of the teaching means and both teacher-students interaction and class attendance. Significant negative correlations were found between teaching strategies and students' attitudes. In the 10th grades, 58.3% opted for an advanced course in chemistry (34.1% opted for a 3 point level course and 65.9% for a 5 point level). The main reason for choosing the course was "interest in the subject matter." This level of interest increased with age.

M7.11

LAWSON AND TOLT TEST CORRELATION IN A SAMPLE OF PANAMANIAN STUDENTS

María Rosa Montanri y Matilde V. de Samudio, Universidad de Panamá, Panamá

Spanish abstract can be found under session number T2.08.

M7.11

A PROPOSAL FOR AN EXPERIMENTAL INTEGRATED CURRICULUM PLAN BETWEEN THE NATURAL SCIENCES AND TECHNOLOGY AT THE PRIMARY LEVEL AND ANALYSIS OF THE PLAN

Guido Alfredo Moncayo y Cesar Augusto Lara, Universidad Pedagógica Nacional, Colombia

Spanish abstract can be found under session number T2.08.

M7.11

BIOLOGY STUDENTS' IMAGES ABOUT SCIENCE: AN EPISTEMOLOGICAL ANALYSIS

William Manuel Mora Penagos, Universidad Pedagógica Nacional, Colombia

Spanish abstract can be found under session number S6.08.

M7.11

RESEARCH UNIVERSITY PROJECT IN SCIENCE TEACHING
José Gregorio Rodríguez, Universidad Nacional de Colombia, Colombia

Spanish abstract can be found under session number M7.09.

M7.11

STUDENT TEACHING GROUNDED IN THE CONSTRUCTIVIST PARADIGM
Marta Quesada Solano, y José M. L. Zamora Calvo, Universidad Nacional Autónoma de Costa Rica

Spanish abstract can be found under session number T2.08.

M7.11

THE DESIGN OF HYPERMIDIAL INSTRUMENTS IN THE TEACHING OF CHEMISTRY AND BIOLOGY
Antonio E. Benavente Morales, Universidad Nacional de San Agustín de Arequipa, Peru

Spanish abstract can be found under session number M4.08.

M7.12

CLASSROOM-BASED ASSESSMENT: FORCE AND MOTION
Zongyi Deng, Michigan State University

The purpose of this study is to develop alternative assessment strategies and tools for the topic of force and motion in middle school science. It is conducted in three phases: A) Identification of key ideas and learning goals on the basis of contemporary science education programs and new curricula frameworks. B) Literature review in which students' misconceptions, historical and philosophical issues in relation to the key ideas are identified. C) Development of performance assessment strategies and tools in which six types of strategies and tasks were proposed. They include observation, interpretation, application, use of graphical and symbolic representation, use of apparatus and measuring instrument, planning of investigation, and performance of investigation.

M7.12

PERFORMANCE ASSESSMENT IN SCIENCE: FROM CLASSROOM EMBEDDED TO STATE ON-DEMAND ASSESSMENT

Michal S. Lomask, Jeffrey Greig, Connecticut State Department of Education and Robert A. Lonning, University of Connecticut

The purpose of this paper is to describe efforts by the state of Connecticut to implement performance assessment in its state-wide assessment program. The state-wide assessment, Connecticut Academic Performance Test (CAPT), was designed not as an achievement test, but rather as a high level performance test for tenth graders. Although there has been a considerable amount of research on incorporating performance assessment into classroom instruction, little is known about implementing these strategies into an on-demand state-wide assessment. Several important issues were addressed in development of CAPT: a) Content of assessment activities, b) Length of assessment activities, c) Administration of performance assessment, d) Cost of assessment administration, e) Cost of assessment scoring. The assessment model developed consisted of two parts: 1) A lab activity administered by science teachers to all students 2-4 weeks before the formal CAPT, and 2) Open-ended questions, including reflection on the results of the experiment and suggestions for ways to improve it aministered as part of the formal CAPT. Piloting of the performance assessment has received mixed reviews from state-wide science teachers.

M7.12

THE NATURE OF BEING VALUED

Mark J. Volkmann and William C. Kyle, Jr., Purdue University

This study focuses on the question: What is the nature of being valued? This research deals with the meaningfulness of work in the lived experience of two science teacher-leaders who participated in the Scope, Sequence, and Coordination project. The hermeneutic phenomenological interpretation of their personal stories coupled with analyses of excerpts from a novel: Goodbye Mr. Chips (Hilton, 1934), a film: To Sir With Love (Clavell, 1966), and the etymology of value (Skeat, 1980, Simpson & Weiner, 1989) enabled me to construct an understanding of the nature of being valued. This interpretation unravels the themes of strength, worth, and integrity within the world of work showing how the experience of being valued is composed of the fabric of these intertwining themes. This study questions the moral and ethical basis of objectivist research.

M7.12

THE ROLE OF RESEARCH IN DEVELOPING PROJECT 2061 BENCHMARKS FOR SCIENCE LITERACY

Sofia Kesidou, American Association for the Advancement of Science

This paper addresses the relationship between research into how students think and learn in science and the development of Project 2061 benchmarks for science literacy. The benchmarks propose a sequence of steps through which students might progress to reach desired outcomes specified for high school graduates in Science for All Americans. Benchmarks result from a process Project 2061 calls "back-mapping." "Back-mapping" involves considering what the component ideas are for a particular learning goal, then imagining lower levels of sophistication at which these ideas might be understood at earlier grade levels. Benchmarks reflect the logical structure of science and an understanding of student learning, gleaned from teachers' experience as well as from research into how children learn. Because such research is limited in many areas, developing benchmarks is a specially difficult task. Kinds of research proving most useful and further research needed in developing and revising benchmarks and curriculum based on them will be identified.

M7.12

THE EFFECTS OF AN INTEGRATED VIDEO-ENHANCED CHEMISTRY CURRICULUM ON STUDENT ATTITUDES AND ACHIEVEMENT IN HIGH SCHOOL CHEMISTRY

Maureen M. McMahon, William S. Harwood, and William G. Holliday, University of Maryland, College Park

The purpose of this investigation is to view the achievement and attitude differences between high school students who will experience a general chemistry course enhanced with The World of Chemistry video series (eight video-enhanced micro-units per semester) and those students who will receive no video-enhanced media interventions within their general chemistry course. In addition to media enhancement, the effects of student ability and teacher instructional modality (teacher/student centeredness) and how they relate to media use will be examined across the dependent variables of achievement and attitude. The standardized High School Subjects Test: Chemistry, individual researcher designed criterion referenced micro-unit tests, and the High School Chemistry Student Opinion Survey are the tools employed to measure student achievement and attitude. Twenty-two high school chemistry teachers and over 1000 high school chemistry students are participating in this year long experimental study. An additional detailed case study is being conducted on a small sample of chemistry students in a high school for the performing arts. At this time, preliminary results indicate reason to suspect significant achievement and attitude differences between the treatment and control groups.

M7.12

COMPUTER MEDIATED COMMUNICATION BETWEEN URBAN MIDDLE SCHOOL STUDENTS AND SCIENTISTS
Brian Murfin, Queens College CUNY

The main goal of this study was to determine the characteristics of effective and ineffective computer-mediated communication (CMC) between urban middle school students and scientists. The sample in this study was made up of twenty urban middle school students. Ten adults, scientists and non-scientists, also participated. An electronic bulletin board system (BBS) was used to link the scientists and students. Nine hundred and eleven messages were posted on the BBS over a ten week period. A content analysis of all messages revealed, among other things, the following: 1) the number of positive messages was greater than the number of neutral or negative messages; 2) the students mainly sent messages to only one individual and did not take advantage of the multiloguing capability of CMC; 3) non-science messages were more numerous than were science messages. Cross gender and cross ethnic interpersonal relationships were successfully established between the students and scientists. Communication genres appeared to be an important context-sensitive factor which influenced whether CMC was successful or not.

M7.13

An Assessment Of The Effects Of Inquiry Instruction On Undergraduate Biology Students' Ability To Solve Problems In Science And Improve Attitudes About Science
Fletcher Brown and Dr. Jane B. Kahle, Miami University

This paper presents the results of a study assessing the effects of inquiry instruction on undergraduate biology students' ability to solve problems in science and improve attitudes about science. The dependent variables in this study were, content understanding, process skills abilities, science attitudes, and the classroom environment. The research design included a quasi-experimental approach and the use of both quantitative and qualitative measures. Results showed significant gains in subcategorizes of all dependent variables mentioned with students who participated in a biology course developed with inquiry instruction as the guiding methodology.

M7.13

WHAT COGNITIVE PROCESS APPEARS TO ENHANCE OR HINDER LVN STUDENTS' PROBLEM SOLVING ABILITIES?
A. William Allen, University of Texas at Austin

The purpose of this study was to describe the cognitive and psychological factors that inhibit Licensed Vocational Nurse (LVN) students from being able to solve medication dosage calculation problems. Two LVN students with similar age, socio-economic and educational backgrounds were chosen from a self-selected population of junior college LVN students. Each subject was interviewed in order to illuminate what confidences and anxieties they had about the medication calculations they were expected to have mastered. Finally, the students were asked to do a talk-aloud as they attempted to do two medication calculation problems of differing difficulty. After they had finished the problems, students were asked to try and remember what they were thinking as they worked on the problems. Results indicated that although students had similar high school mathematics backgrounds and felt confident they could do medication calculations, only the student that consistently identified the goal, restructured the data, estimated the result and selected the appropriate algorithm from memory was successful. The unsuccessful student took twice the time, did not correctly identify the goal or estimate an answer and spent much of the time trying to apply inappropriate rules drawn from memory.

M7.13

PARTNERSHIPS BETWEEN COLLEGES AND HIGH SCHOOLS:MORE PRODUCTIVE OPPORTUNITIES FOR ADVANCED HIGH SCHOOL STUDENTS
Renna B. Calvert, University of Georgia and John R. Wiggins, Georgia Institute of Technology.

This descriptive study was designed to investigate a project developed by the Georgia Institute of Technology to provide high school students with an additional option for obtaining college chemistry credit at Georgia Tech. Chemistry professors from Georgia Tech and three Metro Atlanta area high school teachers integrated the Advanced Placement (AP) Guide and the syllabi for the first two quarter of Georgia Tech chemistry. The purpose of this study was the assessment of the partnership program between the university and the three high schools. Student achievement, student and teachers attitudes, and comparisons with students from a more traditional AP program were investigated. Student reactions concerning this new approach to an Advanced Placement Program were positive. They felt that they received dual benefits from this program: (1) they were better prepared for the AP examination and (2) with an A or B in the course, they were eligible to receive two quarters of college chemistry credit. Teachers believe that students displayed more intense study habits and class participation throughout the entire school year.

M7.13

AN AUTOBIOGRAPHIC ACCOUNT OF PHYSICS TEACHER EDUCATION AND LEARNING TO TEACH PHYSICS IN CHINA

Zongyi Deng, Michigan State University.

The purpose of this paper is to reveal the meanings of physics teacher education and learning to teach physics in China through writing and analyzing professional history. The author provides a thoughtful and compelling life-narrative about his experience as a physics student at a teacher college, his experience as a student teacher at a high school, and his experience as a physics teacher and teacher educator at a normal school. The account highlights the substantial differences in physics teacher education and physics teaching practice between the U. S. and China. The author argues that learning to teach physics involves a common process or transition: a confrontation of the self-image and a subsequent reconstruction of the self-image in light of the classroom reality. The author hopes that this account would be of interest and use to his colleagues in the United States and elsewhere.

M7.13

A PROJECT EVALUATION FOR HOWARD HUGHES UNDERGRADUATE RESEARCH INTERNS

Henderson, Nannette Smith, Shirley M. Smith and Sarah B. Berenson, North Carolina State University

During the first year of the Howard Hughes Project two instruments were used for evaluating the progress of undergraduate interns. The Nature of Science survey (Rubba & Anderson, 1978) and concept mapping, as described by Novak & Gowin (1984) were chosen to examine the interns' organization and representation of their knowledge about the internship project. During the second year of the program this study approaches the undergraduate intern evaluation in a different way. Several evaluative techniques will be used and compared. They are (a) the Nature of Science survey (b) interviews with the participants, (c) discussions of views of science with peers and experts, (d) opportunities for the interns to construct concept maps throughout the internship while discussing those maps with the professors, and (e) "expert" maps that will be constructed by the professors.

M7.13

A PRELIMINARY STUDY OF A RESIDENTIAL PROGRAM FOR COLLEGE SCIENCE, MATHEMATICS, AND ENGINEERING MAJORS

Christian J. Foster, The Pennsylvania State University

Freshman In Science and Engineering (FISE) House has recently completed its first year as an experiment in supportive living. This population of students has a high representation of women and minorities, who are normally underrepresented in science, mathematics and engineering majors. Naturalistic research techniques were utilized to establish the social, physical and historical context for the program. The main source of data was a series of open-ended interviews with representatives of the founding colleges, with representatives of residence life, and with student members of the program. Early findings indicate a high degree of institutional cooperation, high student satisfaction and good general program success. Appropriate programming to fit a diverse populations needs and the effect of separate residence halls on equity issues need to be investigated further from the student's point of view.

M7.13

FACILITATING HYPOTHETICO-PREDICTIVE SUCCESS IN BIOLOGY THROUGH APPLICATION OF PROCEDURAL ANALYSIS AND SKILL THEORY.

Roy Hurst, University of Southern Mississippi

The purpose of this on-going study is to compare procedural tendencies of successful and unsuccessful biology students while solving hypothetico-predictive problems, and to apply a skill theory model in promoting development of appropriate solution patterns in marginal subjects. Subjects completed problem sheets and analyzed their reasoning. Procedural patterns were then obtained for respective prediction success groups through systematic analysis of these protocols, and compared to those reported by D. Lavoie in a previous study. Unsuccessful and transitional problem solvers are currently being exposed to active practice situations in a supportive context including computer simulations, with the goal of transforming their procedural skills. The results are to be finalized by March, 1994.

M7.13

A HOLISTIC STUDY OF THE EFFECTIVENESS OF THE IOWA CHAUTAUQUA PROGRAM: TEACHER, STUDENT, AND LONGITUDINAL PERSPECTIVES.

Chin-Tang Lui, Robert E. Yager and Susan M. Blunck, University of Iowa

Many criticisms/problems of inservice programs in the past, such as lack of a planned or systematic approach, lack of adequate funding irrelevance of perceived professional needs, lack of direction, and ignorance of the latest developments concerning instructional techniques, provoke many people to question the impact of inservice programs for improving the situation of science education. However, inservice education is still recognized by many people as the most important facet of science teacher education. The Iowa Chautauqua Program ia an inservice program which has been validated by the National Diffusion Network (NDN); it is a program that has resolved many of the problems associated with most inservice efforts. In this study, a few major changes in teachers and students were investigated as a result of participating in the Iowa Chautauqua Program. Results indicate that both teachers and students reported significant changes in many areas.

M7.13

A CASE STUDY OF THE IMPLEMENTATION OF A HANDS-ON ELEMENTARY SCIENCE PROGRAM THROUGH AN EDUCATIONAL SERVICE UNIT IN A RURAL AREA.

Dr. Donald McCurdy and Kathryn Underhill, University of Nebraska-Lincoln.

Rural communities frequently have trouble in delivering an effective hands-on elementary science program. Identifying the problems and needs of rural elementary schools through research and interviews, gathering data and then developing and implementing an effective program was the objective of this research. The 14 teachers identified in an Educational Service Unit were trained in the use of the Full Option Science System, (FOSS). Classroom science activities were video taped and the teachers and individual students were interviewed collecting qualitative data about attitude and performance in science learning activities. Results indicated that teachers, when provided with adequate training, support, and science materials will demonstrate more confidence and reduced anxiety and will successfully teach a hands-on science program. Students become more actively involved in their own learning and develop a more positive attitude toward science.

M7.13

STUDENT CHEATING IN COLLEGE SCIENCE CLASSES

Thomas R. Lord, Indiana University of Pennsylvania

A study of undergraduate collusion in science courses was undertaken at a mid-sized eastern university. An equal number of male and female evenly representing each class took part in the survey. Thirty percent of the students were majoring in a science discipline while the remainder were registered in other departments in the university. The survey was answered during the students science courses. The results reveal that eighty percent of the students admitted to collusion of some form in a science course. The dishonesty ranged from cheating on a quiz or exam to plagerizing a written work to forging a professor's signature. The major reason given by the violators was the intense pressure to do well in courses for future employment or entrance into graduate school. The study found that males were more likely to cheat in science than females and freshmen more often to cheat than upperclassmen. More than half the students believed the majority of their classmates cheated in science but only ten percent would report a classmate they knew was cheating to a professor. When the survey was compared to earlier studies on student cheating, it was revealed that collusion in colleges continues to be a severe problem.

M7.13

CRITICAL ANALYSIS OF DEVELOPMENTAL ASSUMPTIONS UNDERLYING YOUNG CHILDREN'S SCIENCE INSTRUCTION

Kathleen E. Metz, Unversity of California, Riverside

Science curricula for primary grade children frequently emphasize observation of concrete objects, study of their properties, and their subsequent categorization. This practice reflects several premises regarded as developmental constraints: *(a)* organization of concrete objects using the logical-mathematical structures of seriation and classification constitute core intellectual strengths or attainments within reach of primary grade children, *(b)* primary grade children cannot comprehend ideas that are not represented by concrete objects as they are "concrete thinkers" and *(c)* primary grade children have not yet grasped the logic of experimentation or scientific inference. The paper analyzes these premises in light of the writings of Piaget, to whom the ideas are commonly attributed, as well as contemporary developmental theory. These literatures and others support the feasibility of a much richer framework for young children's science curricula, where these cognitive processes previously approached as ends in themselves become tools in a more contextualized and authentic scientific inquiry.

M7.13

A DESCRIPTION OF THE CHANGE PROCESS IN A MIDDLE SCHOOL SCIENCE CLASSROOM.

Patricia G. Nason, TX A&M University

The purpose of this study is to examine the processes and implications of change on the reform of middle school science in the classroom of a 7th grade, life science teacher who is attempting to implement the middle school philosophy. The same kinds of higher level thinking skills that should be part of the science curriculum are promoted by the middle school philosophy. Research shows that science educators support inquiry (a general process by which human beings seek information or understanding); however, there is little evidence that the inquiry approach is present in the science classroom.

Several interventions such as involvement in a Science I and II university course, the presence of preservice teachers and university faculty, participation in school families, and various other innovations that impact the school culture are examined; however, the impact of an intervention that emphasizes self-direction by the participant is the primary vehicle of change. The report is a narrative describing the changes.

M7.13

A CROSS CULTURAL ASSESSMENT OF PHYSICAL SCIENCE MISCONCEPTIONS: TAIWAN AND THE UNITED STATES

Tung-Hsing Hsiung and Joseph P. Riley II, University of Georgia

This study assessed physical science misconceptions of elementary preservice teachers enrolled in two Universities, one in Taiwan and one in the United States. The purpose was to identify shared misconceptions across the two cultures. 183 participants were administered a two tier test of physical science misconceptions. Items were individually analyzed for error patterns. Preliminary analysis indicates some concepts share very similar error patterns across the two samples while others show variation. The results have implications for science educators in each country who wish to take student misconceptions into consideration when designing instructional strategies and materials.

M7.13

The Nature of Science. A Documentary Analysis of Teaching Practices That Cultivate Student Understanding

Sheila F. Pirkle, Mary-Ellen Jacobs, Kathy Davis, Frank Cartledge, Paul D. Lee, Louisiana State University, Baton Rouge

Teachers are frequently presented with innovative strategies in inservice sessions, then encouraged to implement them in their classrooms Usually no follow-up support is provided, and teachers -- even if excited by the approaches presented -- often flounder Consequently, little meaningful change occurs in their teaching practice What if ongoing their day-to-day practice? This study seeks to better understand how middle school teachers who have participated in intensive state systemic initiative teacher enhancement projects understand the nature of science and the extent to which they have facilitated the development of their students' understanding of the nature of science To interpret the documents produced by the teacher-researchers including, reflections in on-going journals, portfolios of class use of curricular materials (Operation Physics, CEPUP, CHEM), interview transcripts of teachers and students, changes in the Stages of Concern Survey, changes in the students' Attitude Survey, and responses to questions about the nature of science. Using phenomenological methodology, journal texts and transcripts of group discussions and interviews are analyzed for recurring themes A Stages of Concern survey and survey of students' attitudes is analyzed A preliminary analysis of the teachers concerns about the new curricula and strategies, shows movement towards the use of student-centered instruction A preliminary analysis of students' attitude survey shows a movement toward a more confident posture

M7.13

CHARACTERIZING CHILDREN'S CONCEPTIONS OF HEAT, TEMPERATURE, LIGHT, AND SOUND

J. L. Sanchez-Saenz, C. Gee, M. Svec, and D. Gabel, Indiana University

In a previous study the notion of concept-set has been formulated. This term refers to a word or mental representation which has in practice several related meanings. Evidence for this notion was found in Aristotle's use of the term "hot" in different senses. One corresponds to the idea of temperature, another corresponds to the idea of heat. Some of the other senses, which can be characterized as misconstructions, arise from Aristotle's inability to ascribe to substances the properties of specific heat and thermal conductivity. The analysis of available data on children suggests that the different meanings involved in a concept-set develop as a group, i.e., one can not replace or substitute individual meanings; one has to work on the whole concept-set so as to transform all the meanings involved while changing children's initial characterization of substances or matter. In this study, children's (grades 4-6) answers to questions relating to heat, temperature, light, and sound were analyzed in terms of the notion of concept-set. It is suggested that the origin of some of children's misconstructions or misconceptions of physical phenomena is due to their incapacity to formulate or ascribe new properties to substances or matter.

M7.13

EFFECTS OF CONCEPT MAPPING ON ACHIEVEMENT OF CONCRETE, TRANSITIONAL, AND FORMAL OPERATIONAL COMMUNITY COLLEGE BIOLOGY STUDENTS
Marilyn Shopper, Johnson County Community College

The purposes of this study were to determine if concept mapping enhanced learning using the final examination scores, and to determine if there was trait-treatment interaction between learning level of students and treatment as measured by achievement. The research design was a post test only control group design. The experimental group received concept maps with lecture and developed their own concept maps. Using an analysis of variance, results of the study showed that the effect of concept mapping on achievement was significant. The analysis of variance to determine if there were differences among the experimental group of students at the three levels of cognitive development showed no significant difference, lending support to the idea that concept mapping can be used successfully by individuals of different cognitive levels.

M7.13

ENVIRONMENTAL EDUCATOR PERSPECTIVES ON HOW RESPONSIBLE ENVIRONMENTAL BEHAVIOR IS INFLUENCED THROUGH AN ENVIRONMENTAL STUDY CENTER'S CURRICULUM
Ann Stocker, Florida Institute of Technology.

How are educator beliefs reflected in their teaching? Are they reflected in the responses of their students? Teacher beliefs are investigated in this study of two teachers at an exemplary, outdoor environmental study center that provides K-8 programs for a medium sized school district. A participant-observer qualitative investigation based on the naturalistic paradigm will be developed into a case study. Observations of the two teachers will be made throughout the school year as they interact with classroom teachers and their students. Activities include marine and terrestrial field investigations and island camping. Some classes will be observed before and after the center experience as they follow the environmental center's study unit. Variables include the influences of the center's culture on teacher perspectives. The theories on responsible environmental behavior (REB) that emerge from the teacher perspectives will be compared with existing models of REB.

M7.13

THE EVOLUTION OF A GOAL CONCEPTION OF STATES OF MATTER FOR GRADES 4-7: A CASE STUDY OF CURRICULUM DEVELOPMENT IN A PROFESSIONAL DEVELOPMENT SCHOOL CONTEXT.
Edward Smith, Casy Bain, Thom Dye, Jackie Frese

The paper reports a case study of three teachers and a university collaborator involved in the tryout of a state-developed science unit. The study focuses on changes that took place in the participants' conceptions of what the students were to understand about the different states of matter. Over the course of the project, the participants were involved in planning, teaching, analyzing student responses, and providing feedback on the unit to the writing team. Among the findings were the influence of a textbook model of solids, liquids and gases on the teachers' goal conceptions, the short comings of the textbook model, differences between the teachers and university collaborator in the sensitivity to features of student responses, and the central role of interactions among the teachers, university collaborator and writing team in identifying and addressing the differences in goal conceptions. The findings suggest that textbook models deserve more attention by science education researchers, that curriculum developers need to pay particular attention to teachers' constructed goal conceptions and that institutional arrangements that allow for on-going interaction among teachers, researchers and curriculum developers are useful, if not essential in the improvement of science education teaching and learning.

M7.13

MENTORS AND ROLE MODELS: IMPACTING ATTITUDES OF MIDDLE SCHOOL AGE GIRLS THROUGH INFORMAL SCIENCE EXPERIENCES
Sherry E. Sullivan, Southeast Missouri State University

The underrepresentation of females in the field of science is a topic of concern among researchers in science and education. Previous studies pointing to the need for positive female role models and mentors in science have largely focused on high school and college age students. This investigation examines changes in affective behavior, specifically changes in attitude and values held about science and the role of women in science, of middle school age girls. The girls in the study were exposed to informal after-school mentoring experiences with female scientists and science educators. Both ethnographic and quantitative data was gathered and analyzed during and following the experiences to determine if an increase in positive attitudes and values was evident.

M7.13

A REVIEW OF MISCONCEPTIONS OF ELECTRICITY AND ELECTRICAL CIRCUITS
David P. Tallant, Emory University

This paper is a review of articles and published reports concerning misconceptions about electricity and electrical circuits. This review of literature identifies and describes the misconceptions of students from age 8 through adults, and methods of instruction that have addressed the misconceptions. The review of articles indicates that misconceptions about electricity and electrical circuits may be divided into two primary categories, (a) the concept that current is consumed in a circuit, and (b) the concept of a battery as a source of constant current. Methods of instruction that are purported to be effective in correcting misconceptions have been presented with implications for teaching, teacher education and further research.

T2.04

APPLICATION OF SCIENTIFIC REASONING TO EVERYDAY REASONING PROBLEMS BY PRESERVICE ELEMENTARY TEACHERS.
Ian S Ginns & James J Watters, Centre for Mathematics and Science Education, Queensland University of Technology, Australia.
The purpose of this study was to investigate scientific reasoning in preservice teacher education students. Two groups of students were presented with a problem embedded in a real life senario which required a decision to be made on the basis of a scientific argument. The task represented a situation in which the subject was required to consider the evidence presented as well as any other information beyond that given. In one group the students were presented with the problem and required to evaluate a decision made. In the second group the interviewer required the subjects to articulate their own beliefs, identify existing evidence and any further compelling evidence. Data collected comprised written and oral responses to questions, and transcripts of video recordings of verbal discourse.

TUESDAY -- MORNING

T2.03

AN ANALYSIS OF THE ROLE OF LANGUAGE IN SCIENCE LEARNING
Michael Kamen, Auburn University; Jay Lempke, City University of New York; Bill Carlsen, Cornell University; Larry Flick, Washington State University Tri-Cities; Wolf-Michael Roth, Simon Fraser University

Members of the Special Interest Group on the Role of Language in Science Learning will form a panel to explore the role of language in science learning. A videotaped segment of a classroom science lesson will be shown, and each panelist will present an analysis of the use of language in the lesson indicating specific issues and how they relate to a theoretical perspective, research, and the classroom teacher. The session will conclude with an open discussion about the role of language in the teaching episode viewed.

T2.04

TEACHING-WITH-ANALOGIES: TASK ANALYSES OF EXEMPLARY SCIENCE TEACHERS
Shawn M. Glynn, Michael Law, and Nicole Gibson, University of Georgia

This paper reports the results of new research on the Teaching-with-Analogies Model. The emphasis in this paper is on how task-analysis methodology is being used to examine exemplary science teachers' lessons. The teachers made their "best possible use of analogy-based activities to elaborate upon a key concept that the students had read about in their textbooks." All classes were multicultural, with 18 to 25 students in each class. The lessons were observed, videotaped, and task analyses of the lessons were carried out. The findings identified six key operations for teaching with analogies that teachers should mentally "check off" when explaining new concepts.

T2.04

A REASSESSMENT OF STUDENTS' REASONING ON A PROJECTILE MOTION PROBLEM: A CASE STUDY OF PRESERVICE TEACHER EDUCATION STUDENTS

James J Watters & Ian S Ginns, Centre for Mathematics and Science Education, Queensland University of Technology, Australia

The purpose of this study was to investigate scientific reasoning by preservice elementary teacher education students on a physics problem. Specifically, the reasoning problem was an exercise in predicting the behavior of a falling ball and represented a situation in which the student was required to use knowledge and experience to generate a solution. The problem was presented firstly, in a pen-and-paper format, and secondly as a video clip of a live example. Data collected comprised written responses to three tasks within the problem and transcripts of audio recordings of verbal discourse. Analysis of the performances of the students generated several general conclusions. All students, irrespective of science background, were unable to interpret perceptual experience in a way entirely consistent with acceptable scientific understandings. When confronted with videotape evidence for the correct trajectory of the falling ball, students used a variety of strategies to reconcile theory and evidence. The significance of this study for the education of preservice teachers will be briefly discussed.

T2.05

ENHANCING THINKING SKILLS: DOMAIN SPECIFIC/ DOMAIN GENERAL STRATEGIES -- A DILEMMA FOR SCIENCE EDUCATION

Mansoor Niaz, Universidad de Oriente
Marcia Linn, University of California, Berkeley
Richard Duschl, University of Pittsburgh
Michael Piburn, Arizona State University

There has been a considerable amount of controversy in the science education literature regarding the relative importance of domain specific (declarative knowledge) and domain general (procedural knowledge) teaching strategies. According to some investigators although general skills can be taught and that there is some transfer, it is also the case that knowledge is constructed through a complex interaction of prior knowledge, alternative conceptions, new information and experience and context-relevant skills. This Symposium will provide a framework based on a critical appraisal of philosophy of science, that could help science educators to resolve the dilemma of enhancing thinking skills through domain specific/domain general strategies.

T2.06

EVALUATION OF A CULTURAL, HISTORICAL, AND PHILOSOPHICAL-BASED NARRATIVE APPROACH TO TEACHING HIGH-SCHOOL CHEMISTRY.

Derrick R. Lavoie, Montana State University

The purpose of this research was to evaluate the effects of an instructional strategy employing a cultural, historical, and philosophical (CHP)-based textbook for high-school chemistry. This introductory and supplementary text presents a series of fictionalized narratives illustrating definitive events and ideas in the evolution of chemical science. Students scientific attitudes, conceptualization of chemistry, and cultural, historical, and philosophical orientations toward chemistry were assessed relative to treatment and control groups. Teacher/researcher observations and analyses provided an additional and important source of data for evaluation and modification of the text. Quantitative analysis of questionnaire data revealed significantly greater interest, motivation, and conceptual understanding concerning the subject matter for students in the treatment classes. The teacher/researcher found the CHP-based strategy enjoyable, exciting, and to enhance the learning and motivation of her students. This was evident by the nature of students' questions, the degree of connections students identified between the concepts, students' abilities to work in cooperative groups, and the students' motivation to engage in laboratory and lecture modes of instruction. This research demonstrates that a cultural, historical, and philosophical-based narrative approach to teaching chemistry has tremendous potential to revitalize our traditional secondary-level chemistry curriculums.

T2.06

AN EMPIRICAL MODEL FOR EXPLORING CEILING EFFECTS ON STUDENTS' SCIENCE ACHIEVEMENT IN THE U.S. AND CHINA

Jianjun Wang, California State University, Bakersfield
John R. Staver, Kansas State University

The purpose of this research is to construct an empirical model for exploring ceiling effects on students' science achievement in the U.S. and China. The most recent IEA data sets from the SISS Extension Study in China and the Phase II SISS in the U.S. were employed to estimate regression coefficients in a polynomial model. The investigation of ceiling effect is based on the concave property of the empirical models. The following results are found in the comparative study between the U.S. and China. 1. No ceiling effects are significant for gender factor in the two countries; 2. Ceiling effect is significant on the personal effort factor of the Chinese model; 3. The U.S. model is more complicated than the Chinese Model. The empirical results are discussed in terms of educational, political, social and cultural contexts in the United States and the Peoples' Republic of China.

T2.07

MONITORING NATIONAL STANDARDS IN SCIENCE : THE SCOTTISH APPROACH

Rae Stark, University of Strathclyde, Scotland

Three national surveys of performance in science have been undertaken in Scottish schools over the past seven years. Nationally representative samples of pupils at three stages across primary and early secondary school (corresponding to 8/9 years, 11/12 years and 13/14 years of age) were assessed using a combination of pencil-and-paper and practical tasks. The emphasis has always been on 'doing' science and the assessment package reflects an active, participative view of school science. The responses from pupils have been analysed to provide basic performance statistics at each stage as well as comparisons across stages and between the sexes. Common tasks across surveys provide some measure of change over time on the various categories of knowledge, skills and processes assessed. The third survey in 1993 has just been completed and data analysis is underway. This paper will consider the techniques and procedures used in the surveys, with particular emphasis on the practical phase of the assessment programme. Important concerns are the reliability and validity of the data and the 'quality' of the information which is obtained through national monitoring.

T2.08

PRACTICA DOCENTE ENMARCADA EN EL PARADIGMA CONSTRUCTIVISTA

Marta Quesada Solano, y José M. L. Zamora Calvo, Universidad Nacional Autónoma de Costa Rica

Esta ponencia es el resultado de una experiencia realizada por medio del curso Taller Pedagógico V. Este forma parte del componente pedagógico para la formación de profesores de enseñanza de las ciencias. El grupo involucrado fue de seis estudiantes los cuales poseen título de Bachiller en Biología General o Marina. La experiencia permitió el desarrollo de un modelo de práctica docente de acuerdo con principios constructivistas. Trató entre otras cosa de producir rupturas epistemológicas del maestro y del estudiante con respecto a su propio rol permitir la propia construcción teórica más que la transmisión de conocimientos y la de utilizar el autoanálisis como método para producir la "disonancia cognitiva". Se realiza un análisis de los resultados obtenidos y se hacen interpretaciones donde se señalan los cambios conceptuales y metodológicos obtenidos en el desarrollo del proceso y en los estudiantes.

T2.07

TEST FORMATS AND STUDENT PERFORMANCE

Pinchas Tamir: Hebrew University, Jerusalem
Rodney L. Doran: State Univ NY at Buffalo

The objective of this study was to examine alternative assessment items of science outcomes for American school programs. The major sources were the Biological Science Curriculum Study (BSCS) and the matriculation exams in Israel. The following alternative assessment formats were tried with teachers in New York and California: 1) Multiple choice, 2) Multiple choice with justification, and 3) Essay based on a historical research report. This paper summarizes the results of this study. The teachers were volunteers from inservice meetings and classes. Comment forms for teachers and students were used as a major method of collecting data. The students found most of the items to be interesting yet different from the ones normally experienced in schools. The teachers responded that several items showed real promise, and they hoped to incorporate them into their tests. The relationship of performance levels among different item formats indicate that each assessed different types of knowledge.

T2.08

GERENCIA DE INVESTIGACION EN EL PERU Y LA INDUSTRIA PETROLERA

Esteban Castellanos, International Development Research Center y Universidad Católica del Peru, Peru

La aplicación de ciertos principios de gerencia de investigación a la formación de núcleos universitarios que reemplacen o complementen los institutos estatales desaparecidos o con escasos recursos económicos en el Perú tiene una importancia significativa en el desarrollo del país y la enseñanza de las ciencias exactas y naturales. Las universidades peruanas tienen el desafío de lograr la recuperación de la investigación en el Perú como consecuencia de un desarrollo autosostenido de la enseñanza de las ciencias exactas y naturales. Como soporte se cuenta con la mayor comunicación y relaciones con investigadores peruanos en el exterior, la colaboración internacional y el desarrollo de los programas de postgrado. Por otro lado existen problemas económicos, poco interes y recursos de las industrias en un trabajo conjunto con las universidades y la falta de personal especializado.

T2.08

PROPUESTA EXPERIMENTACION Y ANALISIS DE UN PLAN DE INTEGRACION CURRICULAR ENTRE CIENCIAS NATURALES Y TECNOLOGIA A NIVEL DE LA BASICA PRIMARIA

Guido Alfredo Moncayo y Cesar Augusto Lara, Universidad Pedagógica Nacional, Colombia

Mediante un diagnóstico realizado a una muestra dada se pretende obtener una información que permita proponer un plan curricular, donde se integren areas del conocimiento a través de miniproyectos que faciliten el desarrollo de una metodología constructivista haciendo del alumno el principal autor. A su vez el alumno trabajará fundamentalmente en grupo, lo que conllevará a desarrollar ciertas actitudes y valores que son necesarios complementar con habilidades de tipo cognoscitivo, y manual, iniciándose en la pretecnología tanto al interior como al exterior de la escuela. Lo anterior indica que el alumno a través de los años de estudio básicos, como son los de la básica primaria, comenzará a interpretar los fenómenos naturales y a través de ellos la acción del hombre con la tecnología, desarrollando el análisis, el espíritu crítico y la creatividad conformando así un ciudadano capaz de resolver sus problemas. Por supuesto esto conllevará a iniciar una nue : metodología en la escuela, que exige capacitar a los profesor s requiriendo de materiales indispensables para talleres y experiencias que faciliten el aprendizaje.

T2.09

ELEMENTARY TEACHERS' PERCEPTIONS OF CHANGES IN SCIENCE INSTRUCTION IN A CULTURALLY DIVERSE SCHOOL SETTING

Anjana Ganjoo Arora and Elizabeth Kean, University of Nebraska Lincoln

The purpose of this study was to provide teachers with an opportunity to think about, reflect on, and articulate their past and present experiences that influence changes in their practice of teaching science in a culturally diverse elementary school setting. Three volunteer teachers at different grade levels in the same building were observed in the process of teaching science utilizing newly developed science-kits by the district. Each observation was followed by a discussion with the teacher in which they reflected on the lesson taught. Each teacher was interviewed at different times in the school year to evolve more focused issues involved in their process of change. Ethnographic critical analysis of the collected data is in progress. This analysis will evolve a picture of these individual teachers, shed some light on the use and purpose of science-kits being used for instruction, provide a better understanding of the evolutionary process of becoming an elementary science teacher, and present changes that teachers make in science instruction to meet the needs of culturally diverse students.

T2.08

CORRELACION DE LA PRUEBA DE LAWSON Y LA PRUEBA DE TOLT (TEST OF LOGICAL THINKING DE TOBIN Y CAPIE) EN UNA MUESTRA DE ESTUDIANTES PANAMENOS

María Rosa Montanri y Matilde V. de Samudio, Universidad de Panamá, Panamá

El propósito de la investigación es determinar la correlación que existe, si eventualmente existe alguna, entre los resultados de las pruebas Lawson y Tolt y encontrar el grado de validez y confiabilidad de estas pruebas. A una muestra aleatoria de estudiantes universitarios de las Facultades de Ciencias, Medicina, Humanidades, Enfermería, Arquitectura y Derecho se les administrarán las dos pruebas con una semana de diferencia. Estas miden esquemas de pensamiento indicadores de la presencia del pensamiento hipotético deductivo. A las autoras del estudio les interesa conocer el grado de correlación que existe entre los dos test para poder justificar el uso de uno u otro y conocer el grado de validez de ambos. Hasta el momento, la investigación se encuentra en la etapa de administración de las pruebas mencionadas, habiendo cubierto el 65% de la muestra.

T2.09

IMPROVING THE SCIENCE AND MATHEMATICS PREPARATION OF ELEMENTARY TEACHERS THROUGH SUMMER INSTITUTES, A THREE YEAR STUDY.

Linda R. DeTurs, Eileen Gregory, Nancy M. McAleer and David C. Kurtz, Rollins College

A national movement is underway to better prepare our children to function in a scientific and technological society. One important means of impacting science and mathematics teaching in schools is through teacher preparation programs. It is well documented that teachers who have strong science and mathematics backgrounds and positive attitudes towards science and mathematics teaching are more likely to teach these subjects effectively in the elementary classroom. The goals were to develop and implement summer institute for inservice elementary teachers that would increase and math content knowledge, improve laboratory, computational and computer skills, build confidence in doing hands-on activities, and provide participants with activities suitable for elementary classrooms. Formal and informal assessment demonstrated significant improvement in both content knowledge and positive attitudes towards science and mathematics teaching. On science process skills tests the participants demonstrated high levels of competency. Evidence from surveys, course evaluations and teachers journals provided evidence that participants confidence in teaching science and mathematics was greatly increased through these institutes. Evaluation results demonstrate that this transportable program successfully integrates content background with teaching methodology and provides teachers with the skills needed to effectively teach science and mathematics in the elementary classroom.

T2.09

KNOWLEDGE STRUCTURES OF PRE AND INSERVICE SCIENCE TEACHERS, PEDAGOGY, CONTENT, AND PEDAGOGICAL CONTENT KNOWLEDGE: WHAT DO THE TEACHERS SAY?
Carolyn Dickman, Radford University; Margaret Bogan, Jacksonville State University; Meta Van Sickle, University of Charleston, Norman Lederman, Oregon State University & Julie Gess-Newsome, Utah State University

Longitudinal studies conducted at Radford University, Jacksonville State University, University of Charleston, Oregon State University, and Singapore will be compared and contrasted during this discussion session. Case study method was used to facilitate the study of pre-service teacher's knowledge structures as they progressed through the various education programs. Inservice teachers were included in some studies when the pre-service teachers began student teaching. A discussion of pedagogical, content, and pedagogical content knowledge (PCK) including the PCK model will set the stage for the combined and comparative aspects of the longitudinal studies. Research design issues and findings will be important aspects of the group discussion. These studies indicate that pre-service teachers develop content and pedagogy knowledge structures and form bridges between the two, but that PCK may be an unrealistic challenge for pre-service teachers. PCK may be a salient point of experienced teachers' knowledge structures, but the teachers studied did not describe it as a separate knowledge structure.

T2.11

MATHEMATICS TEACHING IN SECONDARY EDUCATION
Myriam Acevedo Caicedo, y Crescencio Huertas Campos, Universidad Nacional de Colombia, Colombia

Spanish abstract can be found under session number M4.08.

T2.09

TEACHERS' PERCEPTIONS OF AN INNOVATIVE STAFF DEVELOPMENT PROGRAM.
B. Kim Nichols, University of Georgia, John R. Wiggins, Georgia Institute of Technology and Russell H. Yeany, University of Georgia.

The purpose of this study was to examine teachers' perceptions of a unique staff development program. Using astronomy activities, the program familiarized teachers with: multiple intelligences, dimensions of learning, and an interdisciplinary approach to incorporating science into instruction. The program involved the teachers in skill building workshops, engaged them in designing curriculum materials, allowed them to "practice" their skills in a two-week summer camp for children, and reunited the teachers for post-camp workshops. Teachers answered questionnaires, were observed in their classrooms, and were interviewed concerning their experiences. Results indicated that the program had a significant and positive effect on the teachers as evidenced by: (1) their knowledge about teaching as defined by the model presented in the workshop; (2) their ability to plan using the model; and (3) their ability to teach using the model. Analysis of the questionnaire data indicated that mean attitudes and perceptions moved in a positive direction; analysis of follow-up interview transcripts supported these findings and indicated that teachers believed this program to be an effective way of facilitating teacher growth and development.

T2.11

HOW TO USE THE HISTORY OF MATHEMATICS IN A MIDDLE SCHOOL CLASS OF IRRATIONAL NUMBERS
Egberto Agard, Universidad de Panamá, Panamá

Spanish abstract can be found under session number M2.08.

T2.11

SCIENCE TEACHING AND LEARNING ENVIRONMENTS
Gilberto Alfaro-Varela, Rocío Madrigal, y Kenneth Tobin, Universidad Nacional Autónoma de Costa Rica y Florida State University

Spanish abstract can be found under session number T6.08.

T2.11

PARTICIPATORY EVALUATION IN NON-FORMAL EDUCATION
Jorge Bueno, y Nelly Diaz, Ministerio de Educación y Cultura del Uruguay, Uruguay

Spanish abstract can be found under session number T3.08.

T2.11

A CALOMETRIC MODEL
J.J. Andrade Gamboa, y Edgardo Donati, Universidad Nacional de La Plata, Argentina

Spanish abstract can be found under session number T3.08.

T2.11

CHEMISTRY TEACHING IN SECONDARY EDUCATION
Dagoberto Cáceres Rojas, y José Muñoz Castillo, Universidad Nacional de Colombia, Colombia

Spanish abstract can be found under session number M7.09.

T2.11

EXPLORATION AND ANALYSIS OF PHYSICS SECONDARY TEACHERS CONCEPTIONS AND ATTITUDES AND PROPOSAL OF NEW METHODOLOGICAL ALTERNATIVES
Clare Elvira Camargo, Eduardo Zalamea Godoy, y Jorge Enrique Zamora Guevara, Universidad Nacional de Colombia, Colombia

Spanish abstract can be found under session number M7.09.

T2.11

PRECONCEPTS AND THEIR RELATIONSHIPS AS REGARDING EXPERIMENTAL SITUATIONS ABOUT PRESSURE AND FLOATING
M. H. Covarrubias, C. F. Flores, C. L. Gallegos, M. E. Vega, G. M. Rosas, y T. D. Hernández, Universidad Nacional Autónoma de México, México

Spanish abstract can be found under session number M2.08.

T2.11

BIOLOGY TEACHING IN SECONDARY EDUCATION
Angela Chaparro de Barrera, y Martha Orozco de Amézquita, Universidad Nacional de Colombia, Colombia

Spanish abstract can be found under session number M7.09.

T2.11

MASTERS OF CHEMICAL ENGINEERING PROGRAM OF THE AUTONOMOUS UNIVERSITY OF THE STATE OF MORELOS: AN EDUCATIONAL CHALLENGE
Cecilia Cuevas Arteaga, y Edgardo Roldán Villasana, Universidad Autónoma del Estado de Morelos, Mexico

Spanish abstract can be found under session number T6.08.

T2.11

MATHEMATICS INDUCTION: PLAUSIBLE REASONING
Guadalupe de Castillo, y Jorge Hernández, Universidad de Panamá, Panamá

Spanish abstract can be found under session number M2.08.

T2.11

EXEMPLARY BIOLOGY TEACHERS IN ARAB HIGH SCHOOLS IN ISRAEL.
Caesar Anton and Reuven Lazarowitz, IIT Technion, Haifa, and Avi Hofstein, Weizman Institute of Science, Rehovot, Israel

Qualitative and quantitative methods were used to identify teaching characteristics of exemplary and non exemplary teachers, students' perceptions of the classroom learning environment, their attitudes toward biology and reasons for enrollment/non enrollment in advanced biology courses. Ninety observations on ten teachers in 20 classes from five Arab high schools were performed and 515 students' questionnaires were analyzed. Results show that exemplary teachers: a) use classroom management strategies which encourage learning and students' engagement in class activities; b) develop a positive class learning environment; c) tend to use high cognitive level questions; and d) master the subject matter, teaching strategies and techniques of class discipline. When these characteristics were used to categorize teachers into exemplary, medium, and non-exemplary groups, significant differences were found among them in their teaching styles. Students of exemplary teachers expressed positive attitudes toward biology and a majority enrolled in advanced courses. Positive relationships were found between students' attitudes and learning environment subscales of satisfaction, formality, diversity, difficulty, and clarity. A negative correlation has been notice between students' attitudes and the Speed sub scale. No correllations were found between attitudes and grades.

T2.11

CONCEPTUAL RESTRICTORS AND REASONING PROCESSES
C. F. Flores, M. H. Covarrubias, C. L. Gallegos, M. E. Vega, G. M. Rosas, y T. D. Hernández, Universidad Nacional Autónoma de Mexico, Mexico

Spanish abstract can be found under session number M2.08.

T2.11

SIMPLE METHODS FOR TEACHING AND LEARNING ABOUT SOLUBLES AND KPS
Daniel O. Martire, M. Carino, J.J. Andrade Gamboa, y Edgardo R. Donati, Universidad Nacional de La Plata, Argentina

Spanish abstract can be found under session number T3.08.

T2.11

RESEARCH PROBLEMS AND OPPORTUNITIES IN THE TEACHING OF ENGINEERING CENTERED AROUND QUESTIONS DEALING WITH THE ENVIRONMENT
Nascimento Nilo de Oliveira, Universidad Federal de Minas Gerais, Brasil (Centre d Enseignement et de Recherche pour la Gestion des Ressources Naturelles et de l'Environnement de la Ecole Nationale des Ponts et Chaussées, Francia)

Spanish abstract can be found under session number T6.08.

T2.11

EXPERIMENTS WITH CANS
Michel Valero, Universidad del Valle, Colombia

Spanish abstract can be found under session number T3.08.

T2.11

LEARNING ENVIRONMENTS AND OTHER DIMENSIONS
Lilia Reyes, Guillermo Chona, y Daniel Herrera, Universidad Pedagógica Nacional, Colombia

Spanish abstract can be found under session number T6.08.

T2.12

DESIGNING INTERACTIVE VIDEO CASE STUDIES FOR REFLECTION ON SCIENCE TEACHING

Sandra K. Abell and Katherine S. Cennamo, Purdue University, Lois M. Campbell and J. William Hug, The Pennsylvania State University

This paper describes a collaborative project of researchers at two unive/sities to design a set of interactive video case studies for use in preservice elementary science teacher education. The cases focus on conceptual change science teaching in first and fifth grade. The paper discusses the pedagogical and technical considerations encountered during three phases of the project: designing the elementary science instruction, designing the videodisc materials, and designing the science methods instruction. Our experiences are informative to others interested in using integrated media for science teacher education.

T2.12

PRESERVICE ELEMENTARY TEACHERS' CONCEPTIONS OF WHAT CAUSES THE SEASONS.
Ronald K. Atwood and Virginia A. Atwood, University of Kentucky

The purpose of the study was to identify the alternative conceptions held by 49 pre-service elementary teachers on the cause of seasons. Techniques to obtain insight into the teachers' declarative and procedural knowledge were utilized. Criteria were established to classify the responses as: incomplete; reflecting a scientific conception; or, an alternative conception. Approximately 90% of the responses reflected alternative conceptions while only one response was classified as reflecting a scientific conception. The view that the distance between the earth and the sun is a major cause of the seasons was, by far, the most frequently expressed alternative conception.

T2.12

AN EVALUATION OF PRESERVICE ELEMENTARY TEACHERS' SCIENCE CONTENT KNOWLEDGE, PEDAGOGICAL KNOWLEDGE, AND PEDAGOGICAL CONTENT KNOWLEDGE
Carrie J. Gee, Leonardo Sanchez, Michael Svec, and Dorothy L. Gabel, Indiana University

The purpose of this study was to determine whether students who selected science as their area of concentration for the undergraduate degree in elementary education possess the appropriate science content knowledge, pedagogical knowledge, and pedagogical content knowledge before they do their student teaching in local schools. Eleven research questions were developed to examine aspects of each type of knowledge that were specifically addressed in the teacher education program. Data from the 16 students enrolled in the special interdisciplinary science methods course were collected in 4 ways: (1) a Likert Scale questionnaire that assessed each of the three types of knowledge, (2) students' analyses of lesson plans containing correct and incorrect science content with appropriate and inappropriate pedagogical procedures, (3) practicum experiences, and (4) laboratory experiences. A comparison group of students with other areas of concentration also completed the questionnaire and the lesson plan analyses. Data will be analyzed independently by four science educators and assertions made. If no differences are found between the two groups, changes are needed in the preparation of prospective elementary teachers of science.

T2.12

CRITICAL AUTOBIOGRAPHY AS A TOOL FOR PROFESSIONAL EMPOWERMENT.
Nancy T. Davis, Florida State University

The objectives of this presentation are to 1) examine the impact of teachers' writing of critical educational autobiographies on their change process; 2) discuss issues associated with teachers' writing of critical autobiographies; and 3) to propose a model of personal change based on teachers' writings. The autobiographies trace experiences in science teaching and learning and explore changes that were made in the teachers' thinking and actions. Over seventy critical educational autobiographies written by teachers from elementary, middle, and high schools provide primary data for this research. Document analysis utilized category coding techniques of data reduction. Analysis across the teachers' writings suggests components of a personal change process which include disturbance, alternatives, confidence and action.

T2.12

EXAMINATION OF AN INTERDISCIPLINARY PROGRAM IN ENERGY EDUCATION
Brian L. Gerber, Edmund A. Marek, and Ann M. L. Cavallo, The University of Oklahoma

This study was conducted in the first year of the Department of Energy sponsored project, *Energy, Environment and Policy Choices: A Summer Institute for Science and Social Studies Educators*. This was an experientially-based two-week institute that emphasized the interrelationships of energy, environment, economics and politics. The purposes of this study were to determine the influence of the institute on teachers' 1) understanding of energy, environment, economics and politics; 2) development of critical thinking abilities; and 3) attitudes toward learning about energy issues. We will investigate the relationships between institute participants (teachers) and their students in these same cognitive and affective areas. The teachers involved in the institute (N=59) were pre- and posttested on their understanding of energy topics as well as their ability to integrate what they know with politics, economics and the environment. Measures were also obtained on the teachers' attitudes toward learning about energy related issues. During the academic year qualitative assessment of the students will take place via teacher journals detailing student cognitive and affective development, teacher designed tests measuring students' knowledge and attitudes toward energy related issues, and site visits by project personnel.

T2.12

STUDENT SOURCES OF INFORMATION ABOUT SOCIAL ISSUES, THEIR LEVEL OF PARTICIPATION IN SOCIAL ACTION, SCHOOLS PREPARATION OF STUDENTS TO ADDRESS SOCIAL ISSUES, AND STUDENTS PERSONAL CONCERNS RELATING TO SOCIAL ISSUES: A NATIONAL SURVEY OF HIGH SCHOOL STUDENTS

Jon E. Pedersen and Samuel Totten, University of Arkansas

The purpose of this study was to identify the student sources of information about social issues, their level of participation in social action, schools preparation of students to address social issues, and students personal concerns relating to social issues through a national survey. 417 students responded to a 26 item questionnaire focusing on social issues. Results of the study indicate that students receive little information from their science course, don't participate in community service, receive information in class primarily through lecture, and feel they can have limited impact on social issues. In addition, it was clear that students thought the most impact they could have on social issues was either in their immediate family or in their immediate community.

T2.12

VALIDATION AND SUBSEQUENT USE OF AN INSTRUMENT TO MEASURE GROUP PROCEDURAL SKILLS AND ABILITIES

Carol L. Stuessy, Texas A&M University, Gary Tucker, Texas A&M University, Gil Naizer, Ohio State University at Newark, and Elizabeth Bryant, Texas A&M University

The Group Procedural Skills and Abilities Self-Evaluation Questionnaire (GPSAEQ) was developed to assist mathematics and science teachers in monitoring and assessing changes in their perceptions of their group problem-solving abilities. The instrument consisted of 21 Likert-type questions that requested teachers to assess their abilities in five problem-solving categories associated with the solution of complex teaching problems. The categories were Planning and Preparing, Designing, Executing, Assessing, and Reflecting. The instrument was validated and subsequently used as an effective measure of group problem-solving skills in inservice and preservice elementary and middle school teachers.

T2.12

THE IMPORTANCE OF COLLABORATION IN THE REDESIGN OF A COLLEGE-LEVEL INTRODUCTORY SCIENCE COURSE

Janet Schweitzer, Jean Ann Foley, and Bryan Tapp, University of Tulsa

Collaboration was a key component in the success of a revised introductory earth science class that was offered at the University of Tulsa in Spring, 1992. The collaborators included a geoscientist with 10 years teaching experience, a geoscientist with one year teaching experience, and an education specialist. During the planning stages of the course, a theoretical platform was built based on constructivist theory. In addition, tenets of Outcomes Based Education were included. All classes were planned and taught by the 2 geoscientists; the education specialist observed the class once a week and conducted interviews with 4 students. Prior to each class, consensus was reached as to what content would be covered, what methods utilized, and what materials were needed; an organization sheet was filled out setting up the basic structure of the class. The primary problem with this collaborative technique is that it is time consuming. A major advantage of the collaboration is that it results in a blending of experience and knowledge that is much richer than any single person's. Also, the collaboration depersonalizes the classroom experience. This results in instructors that are more adventurous, more open to evaluation, and more analytical. It is this aspect of collaboration that makes it a powerful tool in the reform and redesign of science classes.

T3.02

WRITING AS THINKING:
STUDENT-WRITTEN JOURNALS IN SCIENCE CLASSROOMS

Pamela S. Carroll and Iain Hendren, Florida State University

The presenters, one an English educator and one a science educator, will draw on social constructivist thought within their disciplines to present theories of writing as a meaning-making activity. They will then suggest a variety of practical reasons and ways to incorporate student-written journals into science classrooms, with an emphasis on using the journals to help students learn to think critically and independently. Examples of journals written by middle school students in a general science class and university teacher education students in physical science and chemistry courses, along with excerpts from interviews with instructors at the second -ary and university levels who have implemented student-written journals in science courses, will be highlighted. Discussion will focus on evidence of the increase in student-writers' critical stances as they grew to view the journal as a place to experiment with ideas. The presenters will also discuss potential problems that instructors and students may face when they try to incorporate journal writing in science courses, and will provide practical solutions.

T3.02

PERSPECTIVES OF NON-SCIENCE MAJORS ENROLLED IN A UNIVERSITY CHEMISTRY COURSE.
Frank J. Giuliano, Syracuse University

The purpose of this study was to gain insight into the perspectives of non-science majors taking an introductory college chemistry course. This case study focused on the students enrolled in one laboratory section of a college level chemistry course for non-science majors at a private university in New York state. The class consisted of approximately fifty students. Data for this study were collected through a series of participant observations and interviews. The data collected were coded and analyzed using inductive analysis. Results indicated that students who have been labelled "non-science majors" have developed many strong beliefs about themselves and about science based upon their experiences and interactions with each other and with "science people." Furthermore, the results indicated that the non-science students often associated their beliefs about themselves and about science with their achievement in science.

T3.03

MENTAL MODELS OF THE MOLECULAR STRUCTURE: A STUDY OF PROBLEM SOLVING IN STEREOCHEMISTRY
Mei-Hung Chiu, National Taiwan Normal University, Taipei, Taiwan and Hwa-wen Fu, Duke University

This study examines how students solve problems in stereochemistry, in particular we focus our analysis on the differences of mental models between high and low achievers. Eight students were individually interviewed using a thinking-aloud method. With this method subjects were given tasks and asked to describe *how* they are solving the task. Molecular model kits were used on the basis of personal needs for solving problems. All interviews were tape-recorded and videotaped for later transcription and analysis. The results suggest that high achievers outperformed the low achievers on all four different types of questions, namely linear chemical formula representations, two and three dimensional representations, and real molecular models. The biggest difference is on Type II which requires students to decide what type of isomer a compound is from a planar representation (2D). Surprisingly, only 25% of low achievers are correct which is much lower than the percentage of Type I (linear representation, 62.5%). The smallest difference is on Type IV in which students categorize characteristics of real molecular models. This finding suggest that the low achievers benefit more from concrete models because they help them visualize spatial relationships among atoms. One explanation is that it might reduce the students' cognitive load on visualizing the molecular from 2-D perspective.

T3.02

STUDENT EXPERIENCES IN COLLEGE GENERAL CHEMISTRY: EMERGENT INFLUENCES ON CONTINUING A SCIENCE MAJOR
Lee Meadows, The University of Alabama at Birmingham and Thomas R. Koballa, Jr., The University of Georgia

The affective influences on students' decisions about continuing a science or science-related major were probed in an exploratory fashion using qualitative methods. The population under study was students at a major research university in the southeastern United States taking a general chemistry course required for science majors. Seventeen students, some of whom had switched to a non-science major and some of whom were continuing their science or science-related major, were interviewed using a formal, one-hour, semi-structured approach. Analysis of the interviews was guided by Strauss's dictates for the generation of grounded theory. The core category that emerged was the importance of success in chemistry: Students who succeeded tended to remain in their majors; students who did not succeed switched. The other major themes of students' feelings about science, their academic backgrounds, and the pedagogy they encountered influenced their success but did not directly influence intention.

T3.03

REASONING STRATEGIES USED BY STUDENTS TO SOLVE STOICHIOMETRY PROBLEMS AND ITS RELATIONSHIP TO ALTERNATIVE CONCEPTIONS, PRIOR KNOWLEDGE, AND COGNITIVE VARIABLES
Luisa Rojas de Astudillo and Mansoor Niaz, Universidad de Oriente, Venezuela

Achievement in science depends on a series of factors that characterize the cognitive abilities of the students and the complex interactions between these factors and the environment that intervenes in the formation of students' background. The main objective of this study is to: a) investigate reasoning strategies students use in solving stoichiometry problems; and b) explore the relation between these strategies and alternative conceptions prior knowledge, and cognitive variables. Results obtained show how stoichiometric relations produce conflicting situations for students, leading to conceptual misunderstanding of concepts, such as mass, atoms, and moles. Multiple regression analyses show the relative importance of the different variables, such as developmental level, mental capacity, potential for learning , and disembedding ability.

T3.03

DIFFERENCES BETWEEN ALGORITHMIC AND CONCEPTUAL PROBLEM SOLVING BY NONSCIENCE MAJORS IN INTRODUCTORY CHEMISTRY.

Diana Mason and Frank E. Crawley, The University of Texas at Austin

This investigation identified and described the origins of the differences in the ways nonscience major students solved algorithmic and conceptual problems typically found in an introductory chemistry course offered at the university level. The major aspects of problem solving studied were the differences in the problem-solving strategies used by novices as they solved paired algorithmic and conceptual problems on selected topics: density, stoichiometry, bonding, and gas laws. Differences were established by evaluating think-aloud interviews using a graphical incident-identification method. This type of evaluation is a more quantitative expression of results than that which is usually submitted for most interpretations of think-aloud interviews. Due to the nature of the instrument used, it was possible to evaluate the differences in problem solving strategy on the basis of time required to complete the problem, the number of transitions between episodes of the schema, the episodic time necessary, and the transition rate over time.

T3.06

CLASSROOM ASSESSMENT TO IMPROVE TEACHING & LEARNING IN SCIENCE

James J. Gallagher and Joyce Parker, Michigan State University; Dorcas Lantz, Lansing Public Schools; Amy Cook, Flint Public Schools; & Douglas Leonard, Toledo Public Schools

This symposium focuses on a research project on teachers' use of assessment to improve teaching and learning in middle school science. The project staff and cooperating teachers in these school districts have been working together to understand current assessment practices and to define a process for altering teachers' uses of assessment data to improve teaching and learning. During the symposium presenters will describe the process which involves: focusing on key scientific ideas and skills, anticipating students' difficulties so that they maximize the information on students' understanding, and studying how teachers use the information. There will be a discussion with the audience on the usability of the products, the process developed by this project, and the unresolved questions.

T3.07

ASSESSMENT OF A REFORM PROJECT: A LONGITUDINAL MODEL OF CHANGE

Linda W. Crow, Baylor College of Medicine and Ronald J. Bonnstetter, The University of Nebraska

The need for science education reform has been discussed extensively in the literature. However, few educational reform efforts have undertaken the task of documenting the process or collecting longitudinal data to create both formative and summative findings.

The purpose of this symposium is to promote a discussion of implementation models by examining a current assessment package that includes both formative and summative data for a national reform effort. This open forum will build from the implementation model presented and lay the ground work for a more holistic view of an assessment process that probes the entire school culture including parents, administrators, teachers, and students. We may discover that reform is a contextual process that has commonalties, but demands individualized application to be successful.

T3.08

UN MODELO CALORIMETRICO

J.J. Andrade Gamboa, y Edgardo Donati, Universidad Nacional de La Plata, Argentina

La compresión y diferenciación de conceptos como calor y temperatura, entre otros, suele presentar dificultades debido a la interpretación cotidiana de los mismos. Proponemos aquí el aprendizaje de dichos conceptos a través de un modelo sencillo basado en la analogía: sistema (recipiente), calor específico (base), contenido de calor (volumen de líquido) y temperatura (altura). El modelo permite el análisis de diferentes aspectos de varios procesos térmicos incluyendo los cambios de estado.

T3.08

LA EVALUACION PARTICIPATIVA EN LA EDUCACION NO FORMAL

Jorge Bueno, y Nelly Diaz, Ministerio de Educación y Cultura del Uruguay, Uruguay

Datos recientes demostraron que el sistema de evaluación de las ferias de Ciencias en Uruguay no evolucionaba de acuerdo con los cambios operados en el alumno. En el presente trabajo investigamos los déficits en este sistema de evaluación, para ello se trabajaron en cuatro ferias departamentales y en la feria nacional, detectándose graves fallas, donde los principales actores de este acto educativo alumno-orientador, no a participaban directamente en el proceso de evaluación y en la mayoría de los casos no obtenían explicación sobre el puntaje obtenido. Son evaluados por un jurado que no tiene tiempo para leer los informes presentados, ni para escuchar las explicaciones de la investigación, lo que ocasiona abandono y desinterés por parte de alumnos y docentes. La propuesta es un nuevo tipo de evaluación: la "participativa" donde los actores de este proceso participan además de la comunidad educativa y social, dándose una autoevaluación por alumnos que realizan el trabajo y hay sugerencias de compañeros, docentes, y las personas que participan de la comunidad, transformándose en un verdadero recurso de crecimiento integral.

T3.08

EXPERIMENTOS A LA LATA

Michel Valero, Universidad del Valle, Colombia

La enseñanza de la ciencia no siempre ha permitido ver hasta que punto el conocimiento científicio se integra a nuestro ambiente cotidiano, a pesar de que la ciencia está en todo lo que nos rodea y pocas personas son conscientes de este hecho. Sin ningún equipo especial y solamente con latas de cerveza o gaseosa se pueden hacer experimentos fundamentales que nos permiten investigar y descubrir una ley e integrar diferentes conceptos que facilitan la transferencia de conocimientos de un objeto a otro por medio de la ciencia.

T3.08

EXPERIENCIAS SENCILLAS SOBRE SOLUBILIDAD Y Kps

Daniel O. Martire, M. Carino, J.J. Andrade Gamboa, y Edgardo R. Donati, Universidad Nacional de La Plata, Argentina

Presentamos una serie de experiencias sencillas y suficientemente versátiles para mostrar intuitivamente los conceptos de solubilidad y Kps, como introducción (o en reemplazo según el nivel del curso) a los clásicos prácticos de laboratorio sobre el tema. Adicionalmente, estas experiencias implican la determinación semicuantitativa de Kps y solubilidad y el análisis de la variación de esta última con la temperatura y con el desplazamiento del equilibrio.

SPECIAL SESSION

T3.17

THE NATIONAL SCIENCE FOUNDATION'S DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES

Barbara E. Lovitts and Terry S. Woodin, NSF

NSF's Directorate for Education and Human Resources (EHR) underwent a major reorganization in the summer of 1992. In addition, Congress has placed new pressures for evaluation and accountability on the Foundation. Barbara Lovitts will provide an overview of EHR programs, highlighting their objectives and funding priorities as well as their budgets and proposal success rates. She will give special attention to the programs in the Division of Research, Evaluation, and Dissemination (RED), with particular emphasis on the Research in Teaching and Learning (RTL) program. Terry Woodin will speak in more detail about the programs in the Division of Undergraduate Education (DUE). She will give special attention to the teacher preparation programs, with particular emphasis on the NSF Collaboratives for Excellence in Teacher Preparation.

GENERAL SESSION

T4.15

STUDYING INNOVATIONS IN SCIENCE EDUCATION IN ELEVEN COUNTRIES: A WORK IN PROGRESS

J. Myron Atkin, Stanford University

Every country seems to be dissatisfied with its educational system, and particularly with current programs in science, mathematics, and technology education. The Organization for Economic Cooperation and Development (OECD) has organized a study of key changes that are taking lace in these field within 11 of its 24 member-countries. What innovations are considered important within the anticipating countries? What seems to be driving the changes that are proposed? What are the innovations attempting to accomplish? What challenges do they face? What similarities and differences seem noteworthy cross-nationally? Case studies are being developed within each of the 11 countries to address such questions.

Funded jointly by the Department of Education and the National Science Foundation, the United States is contributing eight case studies to the international effort: three focus primarily on science, three on math, and two on technology. The presentation highlights the issues associated with developing multi-site, multi-level (national, local, classroom), cross-country studies of innovation that are designed to inform science and mathematics education policy and practice. How were common themes identified, and what are they? How were the innovations themselves selected? What are some of the challenges in collecting and reporting relevant information?

T5.03

Ecology and Environmental Science Education: A Research Agenda, Part II

Michael Brody, Montana State University

This session is a follow-up to the first roundtable discussion of this topic at the 1993 NARST Annual Meeting. At that time, a number of interested science educators met to discuss the role of ecology in science education research. That session generated several relevant questions regarding the role of ecology in the science education agenda. Among these questions were: As the natural resource management policies in the USA and the world evolve, what is the role of science education in educating students to understand a new ecological agenda? What research is necessary to help prepare teachers to respond to an increasing number of complex ecological issues? Is the nature of knowledge in ecology and environmental science inherently different than traditional science disciplines? Among the topics to be discussed this year are: substantive differences between educating about the environment compared to traditional disciplines in science education, the role of values and beliefs concerning the environment in science education and the role of gender issues related to environmental education in the science classroom.

TUESDAY -- AFTERNOON

T5.02

SCIENCE TEACHING: THE CONTRIBUTION OF HISTORY AND PHILOSOPHY OF SCIENCE

James Wandersee, Louisiana State University; Nancy Brickhouse, University of Delaware; Richard Duschl, Pittsburgh University; Michael Matthews, University of New South Wales

Three members of this panel will each review a different aspect of the recently published book, *Science Teaching: The Contribution of History and Philosophy of Science* (Routledge, March 1994) authored by Michael R. Matthews.

This book seeks to contribute to science teaching, and science teacher education, by bringing the history and philosophy of science and science teaching into closer contact. The author's belief is that science teaching can be improved if it is infused with the historical and philosophical dimensions of science. It is further claimed that many theoretical debates in science education -- constructivist claims, multicultural science education, values in the curriculum etc. -- can be clarified with the assistance of historical and philosophical scholarship. The book further argues for HPS having a place in science teacher development programs.

The author of the book will respond to the reviewer's comments.

T6.01

Masculinism in Science and Science Education

Panelists
Anita Roychoudhury, Jay Lemke, Nancy Brickhouse, Cheryl Mason, and Priscilla Callison

The underrepresentation of women in science is an extensively studied yet persistent concern of our society. We propose a panel discussion to develop ideas that can guide research on gender differences to a new direction. The panelists will discuss the recent studies on equity issues, the differences in the ways men and women practice science, the inherent masculinity of science and its implications for classroom practice. The primary goal of the panel is to create a forum for the participants to discuss how the research on gender differences can be enriched by incorporating the critiques about the nature of science.

T6.02

IN-SERVICE CHEMISTRY TEACHERS TRAINING: INTRODUCING COMPUTER TECHNOLOGY AS A TEACHING AID

Y. J. Dori and N. Barnea, Israel Institute of Technology, Haifa

A successful introduction of computer aided instruction as a tool for enhancing chemistry teaching depends on positive attitudes of the teachers. The research investigates the effects of in-service training and teachers' self-developed mini-courseware on broadening CAI use for chemistry. It involves follow-up of in-service teacher training aimed at strengthening the confidence of the chemistry teacher in his/her ability to use computers in the classroom. We developed a CAI module on polymers, which was used to introduce the teachers to the variety of possibilities and benefits of using courseware in the current chemistry curriculum in Israel. It was presented as a source for mastery learning, enrichment material, problems and their solutions. As a research tool, the teachers answered pre- and post-attitude questionnaires regarding the use of computers for chemistry teaching in general, and the polymer module in particular. The analyzed data indicated a positive change in teachers' attitudes toward CAI and using computers in their classrooms. As for the polymer module, the teachers indicated that they intend to incorporate it within the curriculum mainly due to the three dimensional polymer models, the animation and the visual effects that explain polymerization and stretching processes.

T6.02

VEE DIAGRAMS OF LABORATORY WORK: HOW DO STUDENTS USE THEM?

Barbara A. Tessier, Mary B. Nakhleh, Purdue University

Vee diagrams have been introduced as a possible tool for aiding in student construction of knowledge. In order to understand how chemistry laboratory students might use Vee diagrams, this technique was introduced to second semester general chemistry students at a large midwestern university. After instruction in the technique and performing the laboratory for which the Vee was completed, students were interviewed to ascertain the level of their understanding of the chemical concepts covered in the laboratory as well as their attitudes towards Vee diagrams. The results indicate a positive attitude towards the use of Vee diagrams with no perceptible change in understanding of chemical concepts. In addition, the results indicate a student perception that lecture and lab activities do not connect and the related perception that Vee diagramming may be one way to help with this lack of connectedness.

T6.02

A COMPARATIVE STUDY OF MEANINGFUL CHEMISTRY LEARNING: ALGORITHMIC, LOCS, AND CONCEPTUAL QUESTIONS

Judith Dory, Aviva Lubezky, M. B. Nakhleh, Barbara Tessier and Uri Zoller, Purdue University

The performance of freshman science and engineering students in three Israeli and American universities on exam questions designed to use either algorithms, lower order cognitive skills (LOCS), or conceptual understanding was investigated. The driving force was an interest in moving chemistry instruction from an algorithm-oriented factual recall approach dominated by LOCS to a decision-making, problem-solving approach using critical thinking and higher order cognitive skills (HOCS). Students' responses were categorized, scored, and analyzed for correlations and for differences between the means across universities, as well as within universities by category of question. We report 3 main findings: 1) students in each university performed consistently on each of the three categories in the order of algorithmic > LOCS > conceptual questions; (2) success with algorithms does not imply success on conceptual questions; and (3) students taught in small classes outperformed by far those in large lecture sessions in all three categories. Implications for improving chemistry teaching will be discussed and translated into actions needed to move from a theoretical base to practical implementation.

T6.02

LABORATORY & LECTURE: BRIDGE OR ABYSS?

Barbara Tessier, Richard Mitchell and Mary B. Nakhleh, Purdue University

An investigation into the lived experiences of students, TAs and instructors associated with a remedial chemistry course was undertaken. The course was taught at a large, midwestern university. This investigation was initiated due to the increasing numbers of students who elect to enroll in the one-semester course prior to taking another general chemistry course. The study utilized qualitative research methods to uncover the perceived connection between the lecture and laboratory portions of the course. The results of the study indicate that not only do students see little connection between the lecture and laboratory, but TAs and instructors as well note little in the way of important connection. The results of this study indicate that we as professional educators need to make much stronger, clearer connections (justifications) for including a laboratory into our general chemistry curricula.

T6.02

THE USE OF EXAMINATIONS FOR REVEALING OF AND DISTINGUISHING BETWEEN STUDENTS' MISCONCEPTIONS, MISUNDERSTANDINGS AND 'NO CONCEPTIONS' IN COLLEGE CHEMISTRY

Uri Zoller, Haifa University-Oranim

It is well established by research that students at all ages hold a wide variety of faulty knowledge structures called "misconceptions". College science students are no exception as far as misconceptions in the chemistry domain are concerned. Systematic administration to biology majors of specially-designed mid-term and term High-order Cognitive Skills (HOCS)-oriented examinations within the freshman courses "General and Inorganic Chemistry" and "Introductory to Modern Organic Chemistry", proved these examinations to be very effective in revealing of, and distinguishing between students misconceptions, misunderstandings, and 'no conceptions'. Substantial number of these, several of which never mentioned in the relevant research literature, were thus disclosed. Modified teaching strategies to overcome the problem by encouraging meaningful learning have been explored and implemented. Our findings, results and accumulated experience suggest that properly-designed examinations may be very effective for revealing, but not for overcoming students misconceptions. However, HOCS-oriented teaching and learning strategies (... and in accord – appropriate examinations) may be very useful in the process of overcoming the problem leading, eventually, to a conceptual change.

T6.03

REFORM OF TEACHER EDUCATION: DEVELOPING PRINCIPLES OF EDUCATING TEACHERS

Michael J. Padilla, Renna B. Calvert, Thomas R. Cooney, Linda C. Grynkewich, Laurie E. Hart, Darwin W. Smith, The University of Georgia.

The purpose of this symposium is to discuss systemic reform in preservice teacher education, using the experience of the Georgia Initiatives in Mathematics and Science (funded under the NSF Statewide Systemic Initiatives Program) as a case study. The three components of the symposium will provide: (1) a short overview of systemic reform and the place of teacher education within this context, (2) a baseline of the current middle grades teacher education programs available in Georgia, and (3) the process and substance developed as a result of the Principles of Educating Teachers (POET). As Georgia has separate middle grades certification, the 31 institutions in Georgia that produce middle grades teachers were surveyed about their programs, with respect to mathematics and science content requirements and middle grades-oriented education classes. Results of the survey provide a baseline for assessing the effectiveness of POET. The POET effort was developed by representatives of the major stakeholder groups, to ensure that an attitude of "buy-in" and not "top-down" prevails. The use of the resultant principles to improve teacher education in Georgia will reflect a common vision that is innovative yet not overly prescriptive.

T6.04

BREAKING THE DIDACTIC TEACHING-LEARNING-TEACHING CYCLE: A CONCEPTUAL CHANGE APPROACH TO SCIENCE TEACHER EDUCATION

Trish Stoddart, University of California, Santa Cruz, Rene Stofflett, University of Illinois at Urbana Champaign, Richard Statler and Dale Niederhauser, University of Utah

This purpose of this paper set is to describe and analyze a conceptual change approach to teacher education. Data are drawn from a series of studies which track cohorts of student teachers through teacher education into their second year of teaching. The studies compare the science content understandings, pedagogical beliefs and teaching practices of novice teachers who participated in conceptual change science methods courses with novice teachers who took traditional science methods courses. The first paper describes the effects of a five step conceptual change approach to science methods instruction on teacher candidates beliefs and practice. The second and third papers use survey and case study methods to investigate whether these effects are maintained through the first two years of teaching. The research findings demonstrate a strong relationship between teachers' personal experiences as learners, their content understandings and their approach to science teaching. The researchers conclude that teachers need to be conceptual learners in order to become concaptual teachers.

T6.06

AN ANALYSIS OF PRESERVICE ELEMENTARY TEACHERS' SCIENCE TEACHING EFFICACY

Robertta H. Barba, University of New Mexico; Patricia F. Keig, California State University, Fullerton

A two-part study of elementary preservice teachers' (N = 258) feelings of science teaching efficacy shows this variable to be well correlated with instructional time, subject preference and teaching ratings, and to be the largest of 10 predictors of science instructional time. A longitudinal portionof the study addressing factors that contribute to preservice teachers' sence of science teaching efficacy revealed that knowledge of generic teaching strategies and science content knowledge is not sufficient to change classroom teaching practice. Preservice preparation in science pedagogical knowledge did impact preservice teachers' feelings of science teaching efficacy and resultant classroom practice. Findings support Ajzen and Fishbein's Theory of Planned Behavior, in that science teaching efficacy is most likely a multifaceted construct, an intention, rather than a single attitude, belief, value or behavior.

T6.06

RELATIONSHIPS BETWEEN MEASURES FOR ATTITUDE, BEHAVIOR, EXPERIENCE, AND SELF CONCERNS FOR SCIENCE TEACHING AMONG INSERVICE ELEMENTARY TEACHERS

B. Patricia Patterson, Wesley College

In this study the extent and nature of relationships between elementary teachers' responses to commonly used measures for attitude, behavior, experience, and concerns with regard to their science teaching were assessed. A self-selected set of 150 K-6 inservice teachers returned a 91 item forced choice survey consisting of an attitude measure with four subscales, commonly used questions about behavior during, and experiences with, science teaching, and a modified version of the Teacher Concerns Questionnaire that included measures of self concerns for science teaching. Statistical analyses identified three groups of teachers with specific correlational patterns of responses to attitude, behavior and concerns questions. Implications of these findings for inservice education are that teachers' inservice needs in science differ and can be assessed a priori through concerns and attitude measures. These findings also support Fuller's original suppositions about the concerns construct in that concerns were found to be subject specific, and that concerns measures did inform attitude and behavior.

T6.08

AMBIENTES DE APRENDIZAJE Y ENSENANZA DE CIENCIAS

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Como base para aprender acerca de los ambientes de aprendizaje y su influencia en el desarrollo de la labor docente, se realiza una actividad de investigación en la que participan maestros y estudiantes de secundaria y profesores. Como medio para la recolección de información y su posterior análisis interpretativo, se aplica un instrumento elaborado para tal fin, se realiza observación de clase y se efectúan reuniones de discusión con maestros y estudiantes. Esta actividad permite visualizar la necesidad de que docentes y estudiantes participen en el análisis de sus propias experiencias como medio para comprender y transformar la cultura en que se desenvuelven.

T6.06

SECONDARY SCIENCE TEACHERS' VOICES: AN INTEGRATED MODEL OF PRAXIS

Meta Van Sickle, University of Charleston, Charleston, South Carolina

Three secondary science teachers were involved in a symbolic interaction study for one calendar year. The data sources were classroom observation, interviews, and artifacts and drawings. The data were analyzed using a constant comparative method and a model was developed based on the data. The teachers' voices on classroom praxis were extremely informative and lead to a three sided pyramid model. The points on the model are 1) the essence of teaching and learning, 2) the nature of science and its content, 3) pedagogy, and 4) values. The teachers voiced the opinion that the model could be used with present and future teachers to help explain the complex set of relationships that occur in classrooms. The variety of relationships are, according to the teachers, the basis of an ethic of caring in their classrooms.

T6.08

MAESTRIA EN INGENIERIA QUIMICA EN LA UNIVERSIDAD AUTONOMA DEL ESTADO DE MORELOS: UN RETO EDUCATIVO

Cecilia Cuevas Arteaga, y Edgardo Roldán Villasana, Universidad Autónoma del Estado de Morelos, Mexico

Desde 1984, la Universidad Autónoma del Estado de Morelos ofrece la maestría en Ingeniería Química a través de la facultad de Ciencias Químicas e Industriales (FCQI). Esta maestría ha tenido como finalidad preparar profesionales en áreas afines para que puedan resolver adecuadamente problemas de ingeniería química que consideren fenómenos fisicoquímicos y su repercusión en el diseño de equipo. Con la reciente reestructuración del plan de estudios, tratados en el presente trabajo, los objetivos se han ampliado, siendo ahora, además de los iniciales, los siguientes: capacitar al ingeniero en la detección de problemas reales y su solución con métodos de vanguardia, desarrollar la habilidad del estudiante en la ejecucion y/o desarrollo de modelos matemáticos, y mejorar sus conocimientos básicos de la ingeniería química para su aplicación en áreas de protección y control del medio ambiente y de administración. El nuevo plan de estudios consta de tres etapas: La primera es el tronco común, el cual está constituído por seis materias básicas en la ingeniería química, la segunda es la especialización, donde se tiene la opción de elegir cualquiera de las siguientes áreas: procesos y aprovechamiento de energía, administración de procesos, y protección ambiental (agua). La tercera etapa la constituye un proyecto de investigación del cual se obtiene la tesis o trabajo terminal.

T6.08

PROBLEMAS Y OPORTUNIDADES DE INVESTIGACION PARA LA ENSENANZA DE INGENIERIA FRENTE A LAS CUESTIONES DEL MEDIO AMBIENTE

Nascimento Nilo de Oliveira, Universidad Federal de Minas Gerais, Brasil (Centre d Enseignement et de Recherche pour la Gestion des Ressources Naturelles et de l'Environnement de la Ecole Nationale des Ponts et Chaussées, Francia)

En el presente trabajo se intenta evaluar el impacto de la crítica a la modernidad sobre el papel del ingeniero en la sociedad y reflexionar sobre los problemas y las oportunidades de investigación para la enseñanza de la ingeniería. El papel del ingeniero en la sociedad se encuentra históricamente asociado al proyecto de la modernidad. La racionalidad en la organización y en la administración de la sociedad, tanto en la utilización y en el control de los recursos y procesos naturales que constituyen el centro de ese proyecto. Su principal objetivo presente en la ideología capitalista, como también en la ideología socialista, sería el conducir a la humanidad en la dirección de la libertad, de la abundancia y del bienestar. En la actualidad el proyecto modernista es puesto en cuestión frente a su incapacidad para proveer democracia y bienestar para la humanidad en su totalidad a partir de los progresos alcanzados en el ámbito científico y tecnológico.

T6.08

AMBIENTES DE APRENDIZAJE OTRAS DIMENSIONES

Lilia Reyes, Guillermo Chona, y Daniel Herrera, Universidad Pedagógica Nacional, Colombia

El presente trabajo fue desarrollado con estudiantes del sexto y octavo semestre de la carrera de Biología. El objetivo principal fue identificar concepciones y creencias acerca de situaciones de enseñanza y aprendizaje en el aula que influyen directamente en el aprendizaje de los estudiantes. El estudio de los ambientes de aprendizaje es pieza fundamental en la identificación, interpretación y análisis de situaciones e interrelaciones en los procesos de construcción social del conocimiento, pues sabemos que las concepciones y creencias del maestro influencian su forma de enseñar y las experiencias y percepciones de estos futuros maestros influenciarán el rol que ellos asuman. El instrumento sobreø ambientes de aprendizaje desarrollado por Fraser y Tobin, 1993 fue traducido y adaptado, pero en el momento de realizar este estudio se vio la necesidad de construir con los estudiantes un instrumento totalmente nuevo con escalas más pertinentes a su realidad y en su propio contexto. Las escalas escogidas fueron siete: tolerancia, independencia, intereses, etica, negociación, aceptación y comunicación. Se consideró en el grupo que la autonomía y la participación son procesos globales que se obtendrán en la medida en que se alcancen las anteriores escalas. Estas escalas reflejan el llamado de los futuros maestros hacia una educación en paz y para el fortalecimiento de esa paz.

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